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Lichen Mapping in Europe

Proceedings of the First Meeting on Lichen Mapping in Europe held at Stuttgart from September, 22nd to 24th, 1989

Editors:

Volkmar Wirth and Hans Oberhollenzer, Stuttgart

Summary

This report presents lectures held at the First Meeting on Lichen Mapping in Europe at the State Museum of Natural History, Stuttgart. The papers deal with current state, plans and problems of lichen mapping in 22 European countries. Furthermore methods of data processing involved in lichen mapping are discussed. Recommendations for international cooperation in a future European lichen mapping project are given. An overview of the different regional mapping projects in Germany is presented.

Zusammenfassung

Dieser Report enthält Vorträge, die während des ersten Symposiums über Flechtenkartierungen in Europa im Staatlichen Museum für Naturkunde Stuttgart gehalten wurden. Die Beiträge behandeln augenblicklichen Stand, Planungen und Probleme von Kartierungsprojekten in 22 europäischen Ländern. Ferner werden Methoden der elektronischen Verarbeitung von Kartierungsdaten besprochen. Die während der Tagung ausgearbeiteten Empfehlungen für eine zukünftige europaweite Rasterkartierung von Flechten werden mitgeteilt. Die verschiedenen regionalen Kartierungsprojekte in Deutschland werden in einem Überblick vorgestellt.

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Preface

From September 22nd to 24th 1989 lichenologists from 18 European states met in the buildings of the Staatliches Museum für Naturkunde (State Museum of Natural History) at Stuttgart to exchange information on current lichen mapping projects and to discuss about starting a lichen mapping project covering the whole of Europe. Regarding the political situation at that time it was a notable success to bring together participants from so many countries from all over Europe; several of our Eastern European colleagues were allowed to visit Germany for the first time.

Actually, the intensity of lichen mapping in the single European countries is rather different. Whereas floristic exploration is still restricted to regions around research centers or to lichen-rich localities in some countries, lichen mapping is being performed in a systematical manner elsewhere. In some cases data resulting from lichen mapping are already stored in and managed by computers and completed distribu-

tion maps will be subjected to numerical analysis. The contributions to the meeting, compiled in this report, will serve to demonstrate the actual situation in the different countries.

Despite a still very unsatisfactory knowledge on the lichen flora of a few European regions, it may be time to think about how we can pave the way for a mapping project covering all of Europe. The differences in the degree of floristic exploration will probably turn out to have less negative consequences than many may be afraid of. Anyway, a preparation of distribution maps of lichens at a European level is bound to work only if it is based on scale grid maps with rather big grid units, a point that gained general agreement among the participants from the beginning.

Lichen flora is changing rapidly. Some parts of Europe suffer a change occurring in an alarmingly high speed. This fact ought to encourage the initation or intensification of national lichen mapping and the start of a European mapping project. Distribution maps yield precious informations on frequency and threat of lichens and will serve as an essential background for precautions to save threatened lichen species by nature protection in all European countries. Several contributions in this volume are proving the fact that the knowledge on lichen distribution is indispensable for a sound evaluation of nature and environment protection projects.

In early autumn 1989, when the meeting was held, the political revolutions in several Central and Eastern European countries were still in their dawn or even unimaginable. Nobody would have dared then to prognosticate the breath-taking speed of change in the overall situation in Europe that we are facing now. Chances for a paneuropean scientific cooperation surmounting political and former ideological boundaries have risen to a once unexpected level. Yet, anthropogenous effects endangering nature, especially air pollution, have never and will never stop at man made boundaries. May this judgement be shared by all political authorities and may it give further impetus to our mutual work and cooperation!

The gratitude of all participants of the meeting is due to the Ministerium für Umwelt, Naturschutz und Reaktorsicherheit (Bonn) (Ministry of Environment, Nature Protection and Nuclear Security) for financial support and to the director of the Staatliches Museum für Naturkunde Stuttgart, Prof. Dr. B. Ziegler, for placing the facilities of the museum at their disposal and for making the publication of this report possible. We are indebted to Mr. M. Heklau for his assistance in preparing the typescripts, to Dr. B. Herting and Prof. Dr. T. Nash III for revising parts of the English text, and to Dr. W. Seeger for his help in publishing this report.

Stuttgart, May 1990
Volkmar Wirth and Hans Oberhollenzer

Lichen Mapping in Europe – Introduction

By Volkmar Wirth and Hans Oberhollenzer

The participants of this meeting are interested in plant geography, in the knowledge of lichen distribution and therefore in mapping of lichens. The major aim of lichen mapping projects is to achieve a better knowledge of the distribution areas of lichen species. This meeting has the task to support these efforts by the mutual exchange of informations on current projects, applied methods, aims and problems. Beyond this we should also be looking for possibilities to initiate lichen mapping at a

European scale or at least seek for a standardization of European lichen maps yet to be published. Taken altogether a lot of precious information is at our disposal here.

More than twenty years ago, when British lichenologists started mapping their country and when one of us was mapping parts of SW-Germany, projects like these were isolated pioneer work and were commented with amazement. A realization of plans to publish a lichen distribution atlas of larger regions or even of whole countries seemed to be unimaginable.

In the meantime substantial increase in lichenological knowledge has been achieved. The number of lichenologists has multiplied. The enormous problems in the identification of species still present in the sixties have decreased considerably, in a degree younger lichenologists may hardly imagine. During the last two decades more and more data on lichen floristics have been accumulated and an increasing number of regional or national lichen mapping projects have been initiated.

Announcing this meeting one could be convinced that circumstances were in favour of it now. There was a growing need for more informations on current projects and future plans in the various countries and time had come to search for possibilities of initiating further national projects and a European lichen mapping project as it has already successfully been achieved with higher plants and bryophytes.

It is not necessary to outline the general scientific importance and significance of lichen mapping or lichen maps here. We would only like to mention that we should be able to give reasons to others, including laymen, why these mapping projects are desirable and why they urgently need realization. Considering the severe decline of many species and the bioindicative function of lichens, convincing arguments can be given.

Nowadays nature protection departments and authorities in several countries are rather susceptible for results of research on sensitive cryptogams, especially on lichens. This is also shown by the fact that this meeting gained ministerial sponsorship. At present lichens are appreciated on behalf of their sensitivity to air pollution, known even to laymen. Lichens are of great importance for purposes of bioindication and deserve consideration in the process of nature protection planning. For governmental authorities lichen mapping therefore has a very practical background beyond its pure scientific aspects. It is hence regarded more and more as useful and desirable.

We therefore have to be aware of an increasing public interest in lichens and we must use the chance now and try to promote lichen mapping on a regional as well as on a national and international scale. It is important to emphasize the significance of lichens as bioindicators and their importance for nature protection, the latter being too much restricted to higher plants. This meeting may thus help some of us to consolidate one's own position concerning relations to officials, or it may as well support a more successful further planning. Being able to refer to similar existing projects in other countries has proved to be very useful.

It was intended to invite representatives of as many countries as possible. Yet, there are several countries, e. g. Bulgaria, Greece, Portugal and Romania, from which at the moment no or little constructive contributions could be expected because lichenology there is still underdeveloped and receives little or no support. Taken altogether contributors from 18 countries, representing 22 countries, present valuable informations on the current status of lichen mapping. Thus a hitherto unachieved complete overview is presented here.

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Part I: Lichen Mapping Projects in Europe
1. National Projects

Twenty-five Years of Lichen Mapping in Great Britain and Ireland

By David L. Hawksworth, Kew and Mark R. D. Seaward, Bradford

With 2 figures and 1 table

Abstract

The progress of the Mapping Scheme of the British Lichen Society, which was initiated in 1964, is reviewed. The evolving methods of data collection, data storage, and map production are described. The first maps were published in 1971 and the first volume of an atlas in 1982. The computer systems now in use provide a wide variety of outputs, including camera-ready maps for printing, microfiches, and colour graphics. In the future, capability to sort by date and site features should be included, and the systems used be designed to be compatible with those developed for other groups of plants.

1. Introduction

The recording of lichens in Great Britain and Ireland has largely followed procedures first introduced for flowering plants and ferns. The system of recording by numbered vice-counties, introduced for mainland Britain by H. C. Watson (1847–59) and extended to Ireland by Praeger (1896), was adopted by W. Watson (1953) for lichens. This tradition has been continued for Ireland (Seaward 1984), but a project to up-date Watson's data for the rest of the British Isles by A. E. Wade (1895–1989) was never completed.

Although the vice-county system provided 152 mapping units, this number proved to be far too few to provide a basis for the establishment of correlations between distributions and edaphic or climatic factors. In April 1954, the Botanical Society of the British Isles initiated a mapping scheme based on 10 km × 10 km grid squares. Mapping cards were designed, converted to individual punched cards, and used to print dot-maps on a modified mechanical tabulating system (Allen 1986). The scheme proved immensely attractive to amateur botanists. The main atlas, published in 1962, included 1.700 maps and 12 overlays (Perring & Walters 1962).

This success stimulated one of us (M.R.D.S.) to propose in 1963 that the British Lichen Society, which had only been founded in 1958, start its own Distribution Maps Scheme. This was approved and launched in August 1964, even though some members were very sceptical that it could ever succeed. By the early 1970s, the Scheme was permeating many areas of the Society's activities, providing a focus for field meetings, promoting studies on herbaria and literature, and acting as a unifying agent between amateur and professional lichenologists. Now that the euphoria surrounding the publication of the first atlas (Seaward & Hitch 1982) has waned, it is appropriate to reflect on the achievements in the quarter of a century since the Scheme was launched, the lessons which have been learnt, and ways in which the Scheme can be developed in the years ahead.

2. Data collection

At the outset, the basic data collection was on cross-off mapping cards. The 1964 card had the names of only 154 species printed on it, selected mainly on the basis of ease of identification; many of the included species were extremely rare and users had to add other names by hand, often extending to attached sheets of paper. These cards were unpopular, and it was not until after the issue of a more practical card in 1968 which included 728 species and followed a new introductory lichen flora (Duncan 1970) that data collection started to accelerate. This card stood the test of time and was not revised again until after the publication of a new checklist (Hawksworth et al. 1980); the new card issued in 1984 lists 1.100 species, almost 75% of the known flora, and also incorporates selected lichenicolous fungi.

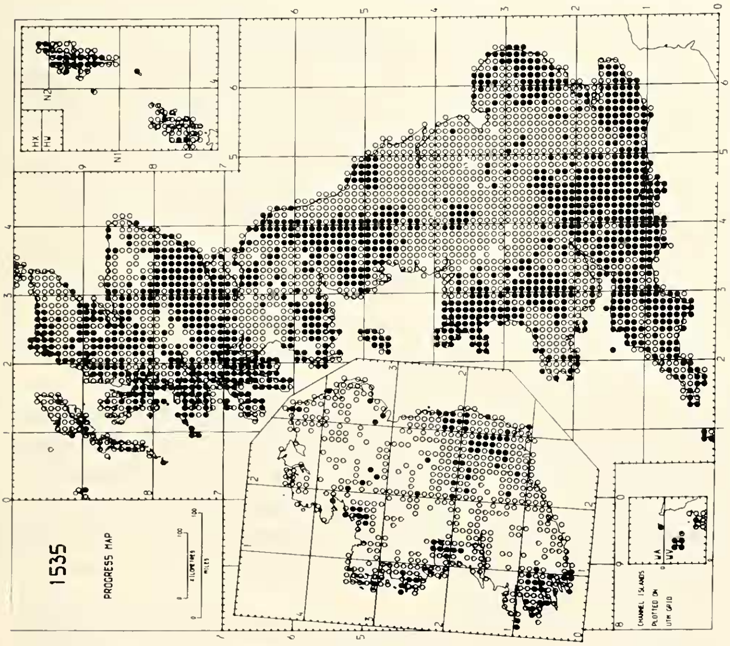
The collection of data on the mapping cards was a daunting task. With about 1600 species and 3850 squares (or part squares) progress could not have been made without the concerted efforts of numerous individuals. At any one time during the last two decades, about one fifth of the British and Irish membership of the Society have been regularly submitting records to the Scheme, with a peak of almost one quarter in the late 1970s (Seaward 1988). The regular publication in The Lichenologist of progress maps showing squares visited, and verbal presentations at Society meetings, encouraged members to visit unrecorded sites. Further, Society field meetings were deliberately held through the 1970s in areas which were short of records.

By 1989 cards had been received for 92% of the squares in England, Scotland and Wales, but for only 58% of those in Ireland; the adequate coverage of Ireland has been hampered by a shortage of fieldworkers resident in that country and a reluctance of many others to visit it. Overall coverage has continued to improve, and the current progress map (Fig. 1) bears testimony to a remarkable voluntary effort. It is also gratifying that the average number of species recorded from each square has continued to increase steadily, the proportion of squares with over 100 species recorded from them rising from less than 14% in 1973 to 40% in 1989 (Table 1). Nevertheless, this should not be any cause for complacency, as while 100 species may well be a realistic total for polluted and built-up regions, certain well-studied areas in rural unpolluted south-west and western regions are known to have around 400 species in a single 10 km square.

Fieldwork is only one aspect of the building up of data for inclusion in mapping schemes. In order to be comprehensive, both to add a historical dimension and to accurately reflect what is known, it is essential that literature sources and herbaria are

Table 1. Numbers of 10 km × 10 km squares for which cards have been received 1973–86.

	No. Species Recorded			No. Squares
	Over 100	50–100	Under 50	covered
1973	238	458	1022	1745
1975	429	682	1113	2229
1979	830	869	1285	2984
1982	902	858	1176	2986
1986	1126	888	1111	3125
1989	1288	881	1048	3217



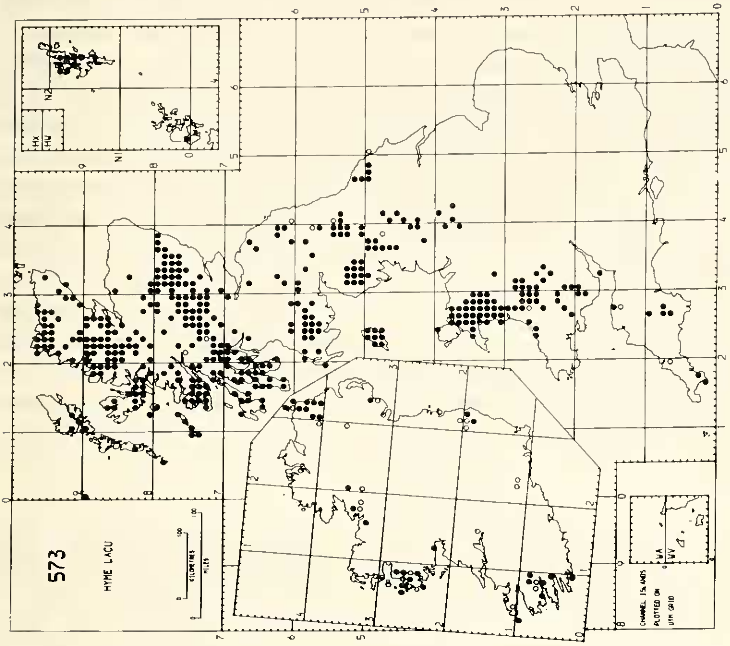


Fig. 1. (left) Progress Map (1989) for the British Lichen Society's Distribution Maps Scheme showing the number of species recorded per grid square (10 km × 10 km) since 1960. – *Dots* = 100 or more species, *circles* = less than 100 species.

Fig. 2. (right) Distribution map of *Hymenelia lacustris* Choisy in Great Britain and Ireland produced directly from computer output from the British Lichen Society's Distribution Maps Scheme Database. – *Circles* = pre-1960, *dots* = 1960 onwards.

also investigated. This is not only an extremely time-consuming task, especially as identifications often have to be verified and synonymies and misapplications of names unravelled, but also one which is less appealing to the amateur than fieldwork. The extent of this information has been assessed. MITCHELL (1971) provided a list of 422 publications including Irish records cross-indexed by vice-county, and HAWKSWORTH & SEAWARD (1977) one of some 2.700 publications relating to the rest of the British Isles, which were also cross-indexed; this last work also included information on the location of herbaria. In practice, these sources have only been used during the late stages of map production for selected species, or where local floras were being compiled. The number of publications relating to the British lichen flora continues unabated; it has been estimated that 870 titles were published during the period 1975–1985 alone (SEAWARD 1988).

In the first decade of the Scheme, the above data were also supplemented by individual species record cards which were suitable for punching and feeding via a card-sorter into the mechanical tabulator used for the initial maps (see above). These cards were mainly used by those producing systematic revisions and abstracting data from herbarium and literature sources.

3. Data storage

By the mid-1970s, it had become clear that the volume of data accumulated could no longer be dealt with satisfactorily by manual means. Mainframe computer facilities at the University of Bradford, a Control Data Cyber 180–830 Dual Processor Fortran 77 using access files and with some machine dependent aspects, was therefore employed. Computer input at that time was by punched cards, and as the original field mapping cards often proved difficult to read, large format transfer sheets had to be used. The programme could not accommodate old records, and checking of the punched cards via line-printer output was extremely laborious; furthermore minor mistakes in punching generated an overall error of 30%. This system was used to generate the raw data for the first atlas (SEAWARD & HITCH 1982).

While the University of Bradford mainframe system continues to store the British Lichen Society's expanding database, split into pre- and post-1960 records, manipulation since 1983 has been by a personal Tektronix 4107 linked to the mainframe. Updating is now on-screen and can be instantaneously validated and accessed either by species or location (i. e. grid reference).

4. Map production

The first maps to be produced by mechanical methods for publication were prepared mainly from individual record cards processed by the Monk's Wood tabulator for *Pseudevernia furfuracea* and its chemotypes (HAWKSWORTH & CHAPMAN 1971), and 14 *Alectoria* s. lat. species (HAWKSWORTH 1972). A series of maps for selected species was then initiated in The Lichenologist, which ran from 1973 to 1977. As Ireland has an independent national grid system, for the first maps grid references had to be converted to those of the base maps.

By 1975, sufficient data were available for the publication of an atlas to be contemplated, and in that year the Natural Environment Research Council (NERC) approved a grant to enable a post-doctoral research assistant to work full-time on the project. From 700 preliminary maps prepared from the Bradford computer database by line-printer, 250 were selected for possible inclusion in the first volume and circu-

lated amongst 20 specialists for additional records. This proved a lengthy process and it was not until 1980 that 176 maps for first publication were finally decided. Rubrics were then prepared by several of the specialists and spots added to base maps manually to produce camera-ready copy for the first volume (SEAWARD & HITCH 1982).

New computer technology has transformed production methods since that time. The Tektronix 4107 now used for data capture (see above), operating on Fortran 77 with GHOST 80 graphics library, enables screen-displayed maps to be converted into a variety of cartographic outputs via microcomputer- or mainframe linked printers. These include microfilm, microfiche, colour graphics, and maps of a quality for camera-ready printing (Fig. 2). Using these facilities, a provisional second volume of the atlas was produced in a mere three weeks from data retrieval to publication (SEAWARD 1985) compared with two years by the manual methods used for the first volume.

Maps can now be produced on demand. Although these have not been subjected to the scrutiny of specialists and do not include supplementary records from other sources as did those issued in 1982, these are a boon to research workers. During the last three years in particular, numerous maps have been prepared specifically for contributors to The Lichen Flora of Great Britain and Ireland (COPPINS et al. 1991).

5. Discussion

It is pertinent to emphasize first that the main impetus for data collection came after the production of a new checklist and a flora for the identification of the commoner species. We believe these were crucial factors in enlisting the essential support of amateurs.

During the first twenty-five years of its existence, the British Lichen Society's Mapping Scheme has seen a revolution in computer technology. If the Scheme were being initiated now, a much more comprehensive field structure for data capture would have been designed with the following main abilities: to sort by date category and substratum, and to retain integral site lists within the main database to enhance the value of the database for conservation purposes.

Further, the software to be used, and more importantly the data elements stored, should be compatible and similarily defined to those being used in other mapping schemes. In the UK alone, for example, there are already atlases available for 49 groups of organisms (HARDING 1985). On a European scale, a scheme is already in operation for vascular plants (COMMITTEE for Mapping the Flora of Europe 1967), and those on fungi as a whole are now starting to be coordinated by an international group established at the Tenth Congress of European Mycologists in 1989. The internationally recognized Taxonomic Databases Working Group for Plant Sciences is already well-advanced in establishing exchange formats for chorological and systematic data elements (e. g. BISBY et al. 1990). There is much to be gained by learning from and then working with those who have already followed almost identical paths. At a time when systematic expertise is scarce in many countries, we must be wary of too many of our number being transformed into narrow computer specialists.

With the technology now becoming available, there is a massive potential for databases with biological records to be used for environmental evaluation and determination of relationships with one or several factors by multivariate analysis. These abilities are particularly important in the light of increasing public concern for environmental and conservation issues. We should endeavour to place ourselves in a position

to answer queries and generate data when required by others. The recent "Red List"of endangered macrolichens in the countries of the European Economic Community (EEC) did not include maps (Sérusiaux 1989); for the next edition we hope national schemes will be linked to generate this key supporting evidence.

6. Acknowledgements

The first author is indebted to the British Lichen Society and the organisers of the workshop for enabling him to participate in the Stuttgart meeting.

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Lichen Mapping in Iceland

By Hörđur Kristinsson, Akureyri

With 4 figures

1. The Icelandic grid system

Since 1970 most data on the distribution of plants in Iceland have been collected on the basis of an Icelandic national grid system proposed by Kristinsson & Jóhannsson (1970). This grid system was based on the division of the country into atlas sheets (scale 1 : 100.000) originally published by the Geodætisk Institut in Copenhagen (Fig. 1). This choice was made since these were the only available large scale maps covering the whole country at that time.

The 40 km × 44 km division of these maps was subdivided into 10 km × 10 km squares, which were numbered by a four digit number as shown in Fig. 2. These square numbers have been increasingly used as part of the location data on herbarium labels and on cards for the collection of botanical data in the field.

The whole of Iceland is covered by 1.138 squares, of which 86 are almost entirely glaciated. Consequently about 1.050 squares are to be recorded.

2. Mapping progress

In the years after 1970, the grid system was used for several detailed local studies: Þjórsárver (Jóhannsson et al. 1974), Hvalfjörđur (Kristinsson et al. 1983), Auđkúluheiđi (Kristinsson & Hallgrímsson 1977), Vesturöræfi and Eyjabakkar (Guttormsson et al. 1981). All these publications contain large scale distribution maps of vascular plants, some of them also maps of lichens or mosses. For many of these studies the squares were further subdivided into 2 km × 2 km squares or 1 km × 1 km squares.

In the years 1974–1978 all squares in Þingeyjarsýsla, (NE Iceland) were systematically investigated for vascular plants. This work resulted in manually prepared distribution maps for that area (unpubl.), showing interesting distribution patterns, most of which could be correlated to certain climatic factors. As a result of this interest grew to extend the work to cover the whole country. In the following years, serving as a professor of botany at the Institute of Biology, University of Iceland, the author made some excursions every summer to uninvestigated or badly investigated areas in Iceland, usually assisted by some botany students. In connection with botanical field work made for various other purposes, information on plant distribution was recorded and gradually added to the card file, both by the author and by several other botanists.

In 1983 a computer program was developed by Þorvaldur Gunnlaugsson to process these data in a VAX 11/780 computer owned by the University of Iceland. In the same year a project was started to feed the field data into the computer, and in addition literature records were analysed and added to the data bank. In 1985 the first distribution maps for all species of vascular plants were printed. Only dots were

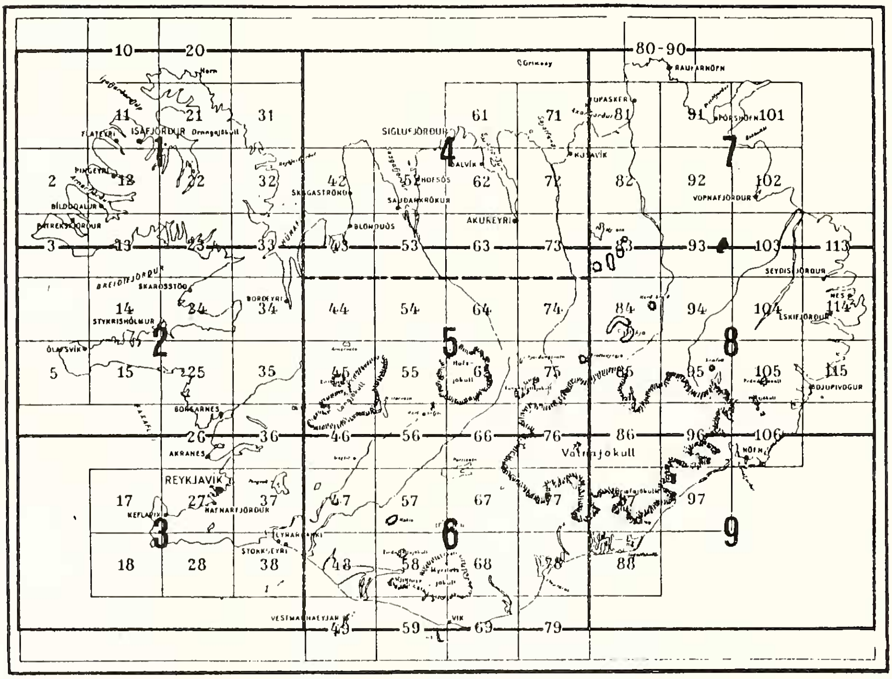


Fig. 1. Division of Iceland on the Atlas sheets in the scale 1 : 100.000, originally published by the Geodætisk Institut in Copenhagen.

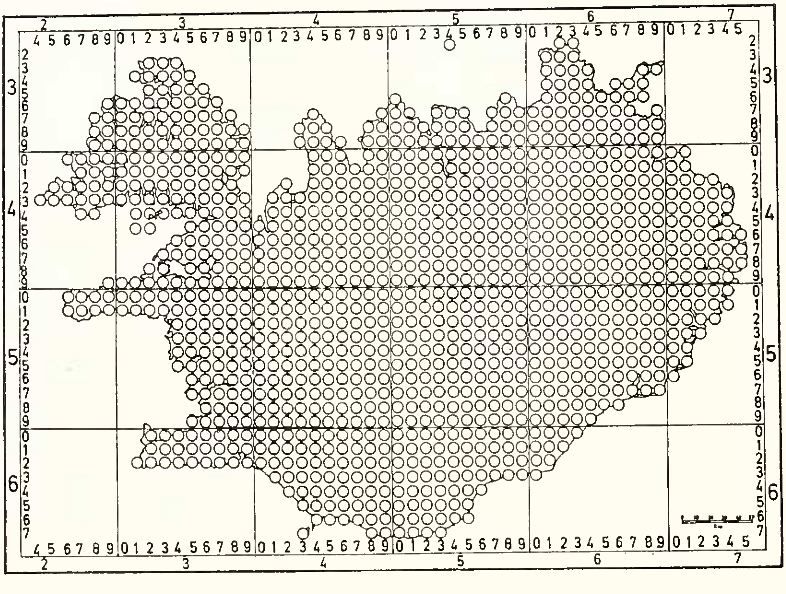
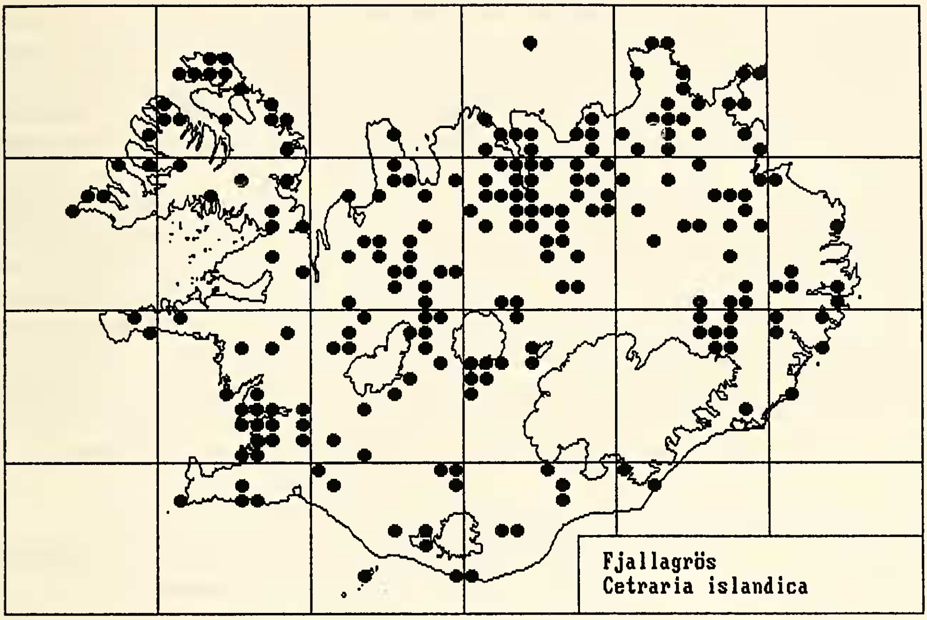
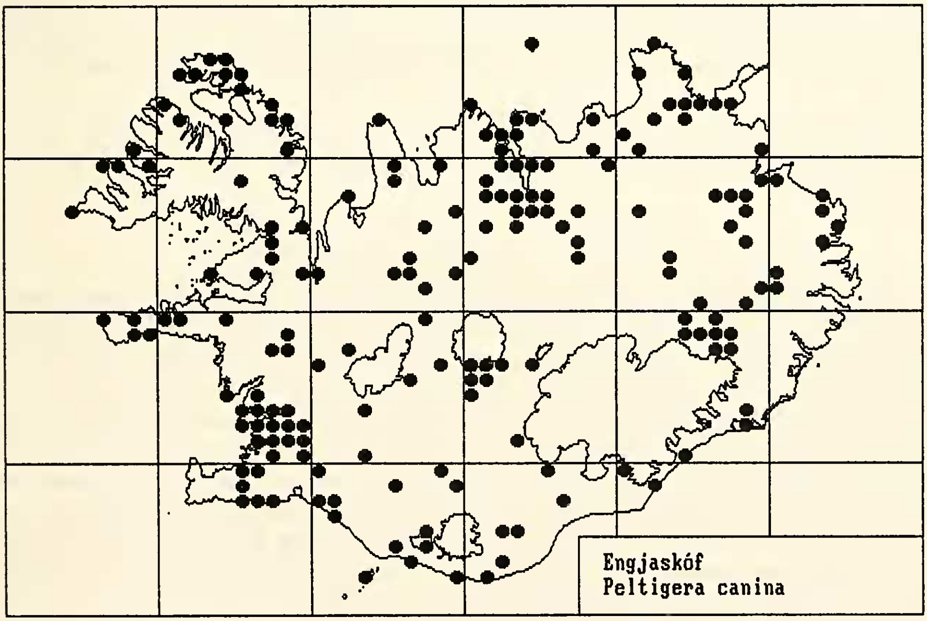


Fig. 2. Icelandic 10 km × 10 km grid used for mapping distribution of plants and animals. The four digit grid numbers include two digits for the vertical column, followed by two digits for the horizontal line.





Figs. 3–4. The distribution of two common lichens, *Cetraria islandica* and *Peltigera canina*. It gives some idea about the density of records for lichens in Iceland.

located and printed by the computer; the background maps in the same scale were copied onto the sheets. These prints made it easy to locate the underrecorded areas for later investigation. They were used as a basis for the distribution maps of vascular plants in Iceland published in Plöntuhandbókin (KRISTINSSON 1986) and its English translation „A Guide to the Flowering Plants and Ferns of Iceland" (KRISTINSSON 1987).

In 1987 the head-quarters of the mapping project moved from the Institute of Biology in Reykjavík to the Museum of Natural History in Akureyri. At the same time a new program called FLORA was developed by GUNNLAUGUR PÉTURSSON to process additional botanical data on IBM/PC computer, and print improved distribution maps. This new programm works in combination with dBASE III PLUS files, and processes information from such files. The last two years have been used to visit areas not recorded before, to fill up the last gaps in the maps. At present, vascular plants have been recorded in more than 1000 squares, and there are only about 30 single squares without any records at all, distributed throughout the country.

3. The lichen flora of Iceland

Lichens were collected in Iceland already in the last century, mainly by CHRISTIAN GRÖNLUND and ÓLAFUR DAVÍDSSON. These records were summarized by DEICHMANN-BRANDT (1903), and again with some additions by GALLÖE (1920). BERNT LYNGE and GUNNAR DEGELIUS contributed a great deal of information on the lichen flora of Iceland in this century (LYNGE 1940, DEGELIUS 1957). In 1967 and 1968 the author made extensive collections in all regions of Iceland. New species for the Icelandic flora discovered in this collection have been published by KRISTINSSON (1972, 1981). Many of the crustose lichens from these collections have still not been identified.

Altogether about 530 species of lichens are known from Iceland at present, and as a result of the relatively low atmospheric pollution, no species are extinct or even endangered.

4. Distribution maps of lichens

Some of the local, large scale mapping projects mentioned above include lichen maps (JÓHANNSSON et al. 1974, GUTTORMSSON et al. 1981, KRISTINSSON et al. 1983). On a country-wide basis the recording of lichen distribution is far behind that of vascular plants. This is caused by the fact that there are very few resident botanists in Iceland collecting or recording lichens. Distribution maps of common lichen species like *Cetraria islandica* or *Peltigera canina* (Fig. 3 and 4) give some idea on the status of mapping. The most common lichens are recorded in about 150–200 squares out of 1050. Nevertheless, these records are rather evenly distributed throughout the country and give a fairly good idea of the real distribution pattern. At present, the lichen records are being processed by the same method and the same grid system as already described for the distribution of vascular plants.

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Retreating Lichens in Southernmost Sweden

By Ingvar Kärnefelt, Ulf Arup and Stefan Ekman, Lund

With 10 figures

Summary

The current status of 94 lichen species, of which 83 are extracted from the Swedish Red Data list, has been investigated in Skåne, the southernmost province of Sweden. The results, including over 1000 field records, indicate a retreat connected with environmental problems, especially air pollution. 41 species have disappeared, 16 species are considered endangered, 11 species are considered vulnerable, 7 species have become rare and 7 other species are care-demanding. Three species are increasing in frequency. Maps of past and present distributions are presented for *Bacidia rosella, Fellhanera bouteillei, Gyalecta ulmi, Lecanactis amylacea, Opegrapha vermicellifera, Parmelia revoluta, Phlyctis agelaea, Pyrenula nitida, Ramalina obtusata* and *Sticta fuliginosa*.

1. Introduction

The double organism nature of lichens makes them, perhaps more than any other organisms, extremely sensitive to any changes in the environment which can cause instability in the well-balanced physiological system between the two bionts forming the thallus.

Since the pioneer work of Nylander (1866) during the last century it has been well-documented that the lichen flora vanishes from regions with strongly polluted air. Comprehensive research data concerning the retreat of the lichen vegetation related to air pollution have been published during the last decades in many western countries (Hawksworth et al. 1973; Leblanc & Rao 1975; Wirth 1976). A relatively large amount of papers has been published also in the Nordic countries, discussing the changes in the lichen vegetation of local regions related to air pollution (Arvidsson & Skoog 1984, Hedlund 1983, Hultengren 1987, Ramkær 1984, Skye 1968, Søchting & Ramkær 1982). A negative ultrastructural change in the lichen thalli associated with the general acidification was, however, not established until this decade (Holopainen & Kärenlampi 1984). The physiological response mainly concerns a general degradation of chlorophyll causing drastic changes in the respiratory rates (Fields 1988).

During the last few years, however, several other factors, e. g. a general change in the use of land and the improved methods in forestry have also been considered as being involved in the retreat of lichen vegetation (Esseen 1983, Hallingbäck 1986, Löfgren & Moberg 1984). More attention is also paid to the importance of maturity and continuity of the lichen localities (Andersson & Appelqvist 1987).

2. Methods

This project, which started in 1987, was originally planned to register changes in the lichen vegetation primarily in the province of Skåne. Later on other provinces in southernmost Sweden were also included. The province of Skåne in particular is very suitable for this kind of project because of the well documented changes in the cultural landscape during this century

(EMANUELSSON et al. 1985). Additionally several local investigations on the lichen flora had been carried out earlier which make a comparison in time possible (ALMBORN 1955, DEGELIUS 1941, MALME 1934, 1935). ALMBORN's investigation of the southern lichen element in Scandinavia was also a valuable source of information (ALMBORN 1948).

The original plans mainly concerned a reinvestigation of earlier known localities from the investigations mentioned above. These plans, however, have now been modified to include also the registration of newly discovered localities. An increase in frequency based only on a reinvestigation of old localities would otherwise be impossible to detect. Additionally, we have also included a system of judging the vitality status and the size of the populations of the investigated species.

Today, the list of investigated species within the project comprises 94 species of which 83 are compiled from the list of 214 endangered lichen species in Sweden (FLORAVÅRDS-KOMMITTÉN 1987).

3. Results

The investigation concerning the 94 lichen species so far comprises over 1000 records form field observations. Some trends and statistics regarding various categories of threats including comments on certain species are presented. Air pollution, modern forestry, change in the use of land, removal of old solitary trees and tree avenues are all important factors which affect the lichen flora negatively. Very often, not just one threat, but combinations of these cause the retreat of the lichen vegetation. It is also clear that a certain degree of maturity and continuity in the habitat is required for successful regeneration and dispersal of many corticolous lichens (ANDERSSON & APPELQVIST 1987, ARVIDSSON et al. 1988). When lichens grow at localities with long continuity (climax habitat) they seem to be able to withstand more air pollution than elsewhere.

3.1. Species sensitive to acidification

Among species which presumably have disappeared mainly because of acidification several different categories can be discerned:

(1.) Large species which require continuous humidity and some species with cyanobacteria within the genera *Collema*, *Dendriscocaulon*, *Leptogium*, *Lobaria*, *Nephroma*, *Pannaria*, *Parmeliella* and *Sticta*.

(2.) Small species which grow on exposed twigs of trees and shrubs e. g. *Fellhanera bouteillei* and *Xanthoria lobulata*.

(3.) Species growing on wood, fences and old wooden buildings e. g. *Calicium abietinum* and *Cyphelium trachylioides*.

(4.) Species occurring mainly in forests and pasture-land with scattered trees e. g. *Bacidia rosella*, *Lecanactis amylacea* and *Parmelia revoluta*.

3.2. Species sensitive to new methods in forestry

Some species which earlier formed elements in the genuine woodland must have been extremely sensitive to the new rational methods in forestry which have developed during the last few decades, e. g. *Lecanora glabrata*, *Opegrapha vermicellifera*, *Pyrenula nitida* and *Thelotrema lepadinum*. Several newly discovered localities have been registered which, however, should be interpreted as representing very old populations rather than an increase in frequency.

3.3. Disappearing species with a northern distribution

Some other interesting species which appear to have retreated drastically belong to a northern element in the Nordic lichen flora, i. e. *Cladonia bellidiflora, C. cyanipes, Peltigera venosa, Umbilicaria cylindrica, U. hyperborea* and *U. proboscidea*. Out of a total of 20 different records from 14 earlier known localities for these northern species only one could be reconfirmed during 1988. It is known that species growing near the border of their distribution area are often more sensitive to changes in their environment than in central parts of their area.

4. The 94 investigated species in the province of Skåne

41 species have vanished: *Arthonia byssacea, A. tumidula, Bactrospora dryina, Bryoria bicolor, Calicium abietinum, Cladonia cyanipes, Collema fragrans, C. furfuraceum, C. occultatum, C. subflaccidum, C. subnigrescens, Cyphelium trachylioides, Dendriscocaulon umhausense, Evernia divaricata, Fellhanera bouteillei, Leptogium cyanescens, L. palmatum, Letharia vulpina, Maronea constans, Moelleropsis nebulosa, Nephroma laevigatum, Pachyphiale cornea, Pannaria conoplea, P. rubiginosa, Parmelia caperata, P. centrifuga, P. reddenda, Parmeliella plumbea, Peltigera venosa, Ramalina calicaris, R. thrausta, Schismatomma abietinum, S. graphioides, Sphinctrina anglica, S. leucopoda, Sticta fuliginosa, S. sylvatica, Umbilicaria cylindrica, U. hyperborea, U. proboscidea* and *Xanthoria lobulata*.

16 species must be regarded as endangered: *Bacidia rosella, Calicium quercinum, Chaenotheca hispidula, Coniocybe coniophaea, C. peronella, Diploicia canescens, Gyalecta truncigena, Lecanactis amylacea, Lobaria amplissima, Menegazzia terebrata, Opegrapha ochrocheila, Parmelia revoluta, Pertusaria velata, Phaeophyscia endophoenicea, Ramalina obtusata* and *Usnea florida*.

11 species have been registered as vulnerable: *Catinaria laureri, Cladonia bellidiflora, C. parasitica, Enterographa crassa, Leptogium gelatinosum, Lobaria virens, Normandina pulchella, Pertusaria multipuncta, Phlyctis agelaea, Pyrenula nitidella* and *Sphinctrina turbinata*.

7 species have been registered as rare: *Arthonia leucodontis, Catillaria sphaeroides, Cladonia incrassata, Gyalecta flotowii, G. ulmi, Lecanora glabrata* and *Parmelia tiliacea*.

7 species have been considered care-demanding: *Arthonia impolita, Lobaria pulmonaria, Opegrapha vermicellifera, Parmelia elegantula, Pyrenula nitida, Thelotrema lepadinum* and *Xanthoria calcicola*.

6 species which are on the Swedish Red Data list have been considered as not threatened in Skåne: *Arthonia spadicea, Arthothelium ruanum, Microcalicium arenarium, Opegrapha viridis, Physconia grisea* and *Schismatomma decolorans. A. spadicea* and *A. ruanum* seem to have increased in frequency within the province probably due to an increase of suitable localities. *S. decolorans* is a sorediate species on old oak trees and formerly known from only a few localities. It seems to be competitive and not much affected by air pollution which is probably the reason why it has increased in frequency.

5. Comments on some of the investigated species

Bacidia rosella

Within the investigated region *Bacidia rosella* occurs on *Fagus sylvatica* in humid forests but it can also be found growing on trees in avenues. The species must be regarded as endangered within the region but it has also become rare in the whole country. Only a few localities are known from Skåne where *B. rosella* occurs in a very limited number of individuals (Fig. 1). The increased acidification and changed methods in forestry presumably are the main reasons for the decline, but since *B. rosella* belongs to a more temperate Central European element climatological changes may also be involved.

Fellhanera bouteillei

This species occurs on branches of spruce (*Picea abies*) where it obviously prefers the lower branches which are more protected from precipitation. *Fellhanera bouteillei* is regarded vulnerable in the whole country, but it seems to have disappeared from Skåne where it was formerly known from relatively many localities (Fig. 2). Like some other species which grow mainly on exposed branches, this species appears to be very sensitive to acidification.

Gyalecta ulmi

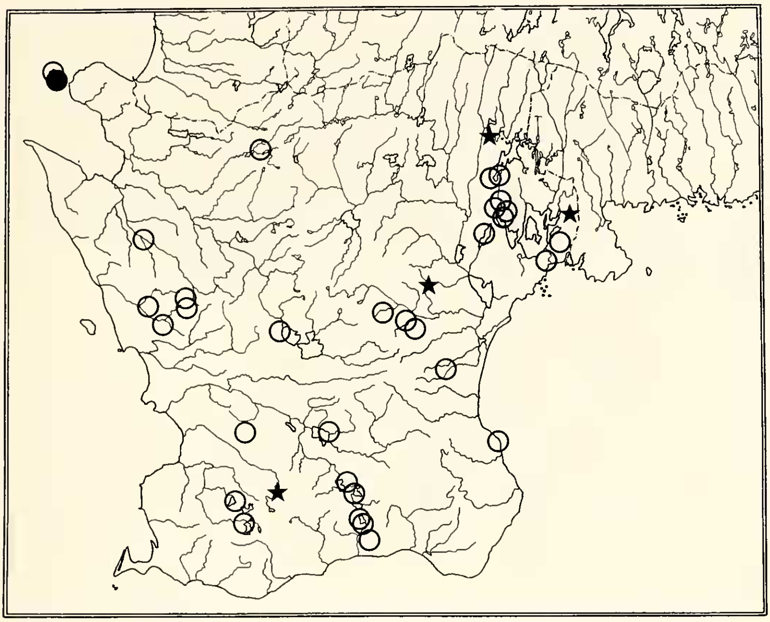
This species occurs mainly on deciduous trees in localities with long continuity and maturity. In the whole country *G. ulmi* is regarded as care-demanding but it has become rare in Skåne. The retreat of the species is presumably related to the removal of suitable habitats. Four of the presently known localities are located in wooded meadows in the northeasternmost part of Skåne, where the populations are actually rather large (Fig. 3).

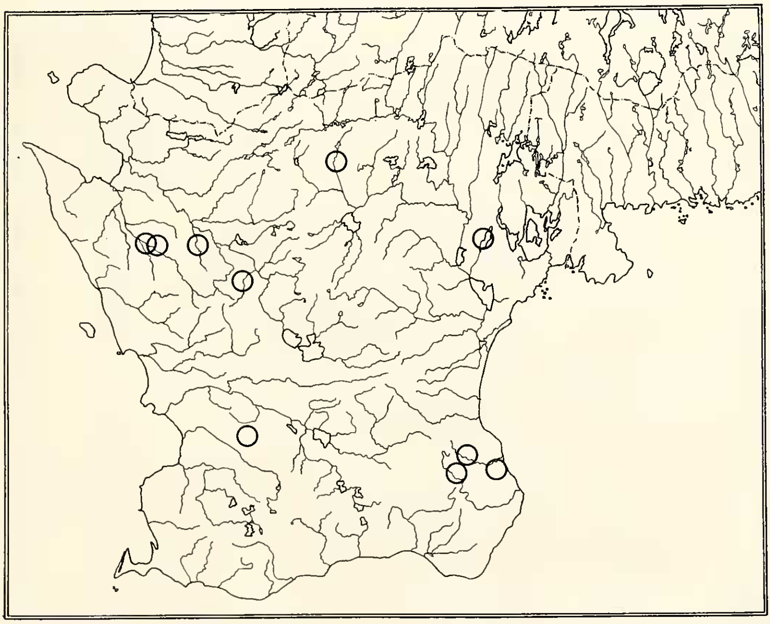
Lecanactis amylacea

Lecanactis amylacea mainly occurs on rough bark of old oak trees (*Quercus robur*) growing as solitary trees or in groups in pasture-land. The species must be regarded as endangered in the whole country also including Skåne where it was earlier known from a number of localities (Fig. 4) and then often associated with *Arthonia impolita*. At present *L. amylacea* is only known from two localities within the province, at both with only very few individuals. On many localities where *L. amylacea* formerly grew together with *Arthonia impolita* only the latter still exists. This indicates that *L. amylacea* is very sensitive to air pollution and that this may be the main reason for the retreat of this species.

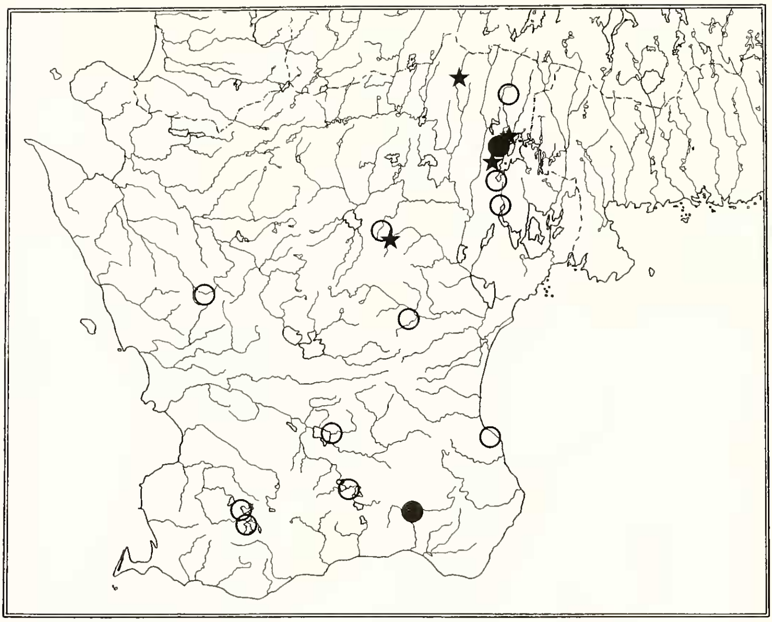
Opegrapha vermicellifera

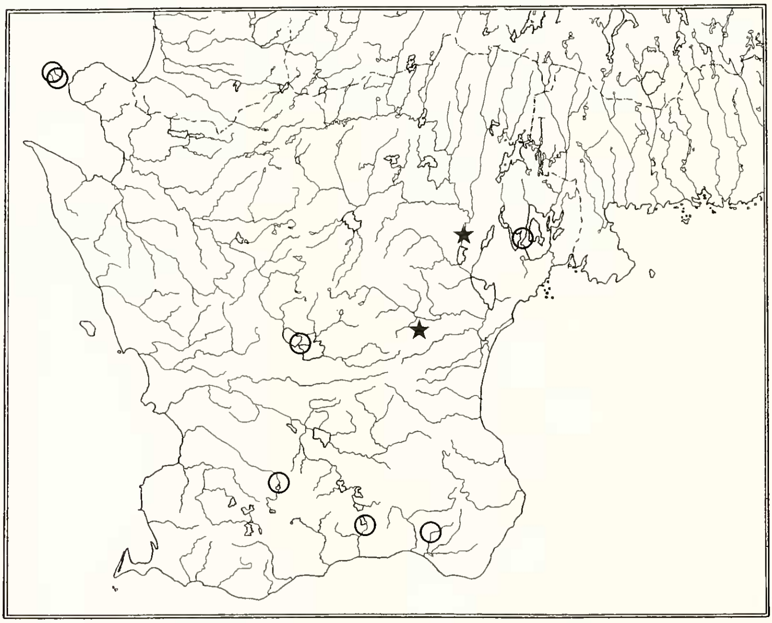
Opegrapha vermicellifera which belongs to a Central European element mainly occurs on deciduous trees in shaded habitats. It is considered to be rare in the whole country, but is care-demanding in Skåne. The species has disappeared from a number of earlier known localities in Skåne but several new localities have also been discovered (Fig. 5). The species is often very inconspicuous and may have been overlooked previously.



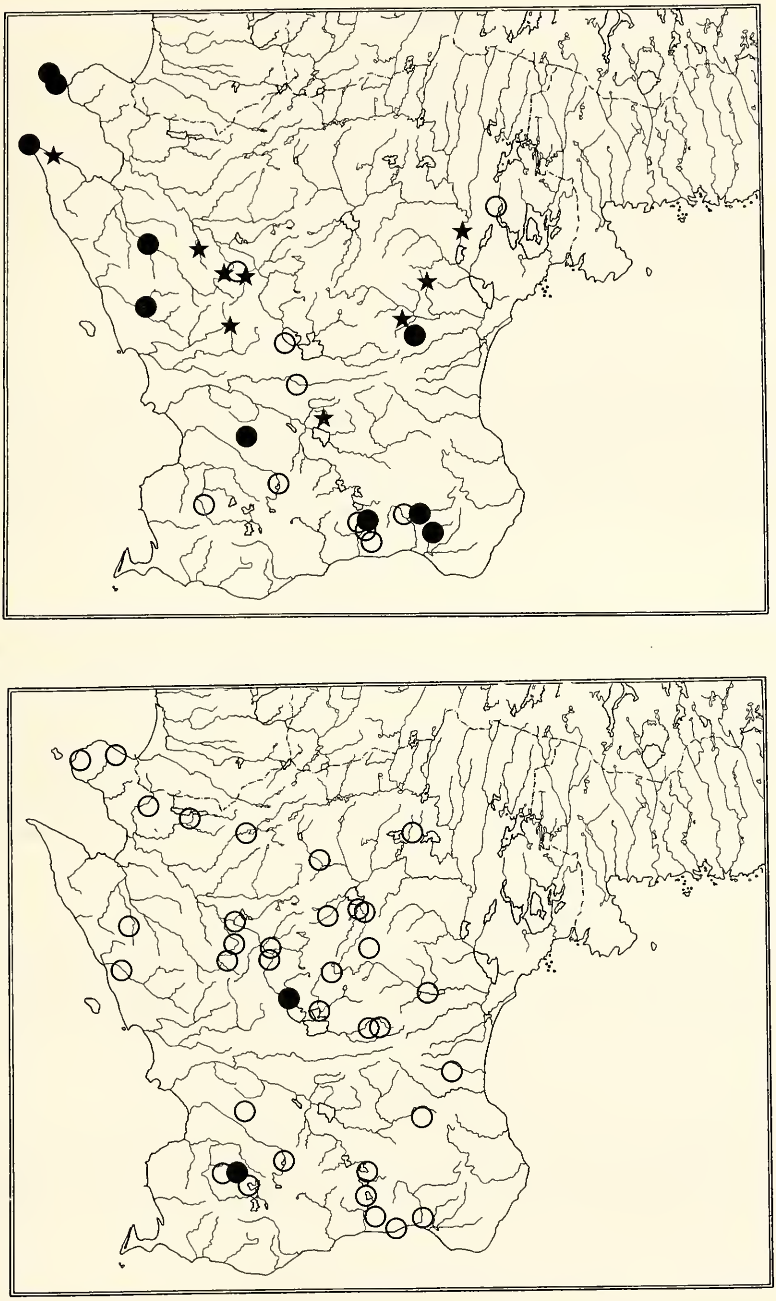


Figs. 1–2. Former and present records of lichen species in Skåne, the southernmost province of Sweden. – 1. (above) *Bacidia rosella*; – 2. (below) *Fellhanera bouteillei*. – Symbols for all figures: *open circle* = earlier known locality, *filled circle* = confirmed earlier locality, *star* = newly discovered locality.





Figs. 3–4. Former and present records of lichen species in Skåne. – 3. (above) *Gyalecta ulmi*; – 4. (below) *Lecanactis amylacea*.



Figs. 5–6. Former and present records of lichen species in Skåne. – 5. (above) *Opegrapha vermicellifera*; – 6. (below) *Parmelia revoluta*.

Parmelia revoluta

In the Nordic countries *Parmelia revoluta* occurs exclusively on *Alnus glutinosa* along streams, lake shores and in humid meadows. The species is considered vulnerable in the country but at present it is endangered in Skåne. From over 34 earlier known localities only 2 have been reconfirmed and it occurs in only a few individuals (Fig. 6). The retreat of this species is remarkable since many of the earlier known localities seem almost unchanged. The main causes for the retreat of this mainly suboceanic Western European species are presumably acidification in connection with general climatic changes.

Phlyctis agelaea

Phlyctis agelaea occurs on various deciduous trees both in forests and in open localities like avenues. This species is considered to be care-demanding in the whole country but it is vulnerable in Skåne. It has disappeared from a number of earlier known localities within the province but also a number of new localities have been discovered (Fig. 7). It occurs in only a few individuals in most of the known localities.

Pyrenula nitida

This very characteristic species occurs mainly on *Fagus sylvatica*. It is considered care-demanding in the whole country also including Skåne. In Skåne in particular *Pyrenula nitida* was earlier a characteristic element in the *Fagus* woodland where it is still found in many localities (Fig. 8). It is, however, very clear that the species is retreating in the province and in the whole country, since the vitality of the investigated populations seems to be declining and the number of individuals seldom seems to be very high. *Pyrenula nitida* is apparently very sensitive to air pollution.

Ramalina obtusata

Ramalina obtusata occurs on bark of deciduous trees particularly in avenues and in pasture-land. The species is considered to be care-demanding in the whole country but it is endangered in Skåne. One of the earlier known localities has been verified and one new locality was found in the northeasternmost part of the province (Fig. 9).

Sticta fuliginosa

Sticta fuliginosa was earlier known from six relatively humid localities in Skåne (Fig. 10). The *Sticta* species appear to be extremely sensitive to environmental changes and acidification and they must be regarded as endangered in all Western Europe.

6. Acknowledgements

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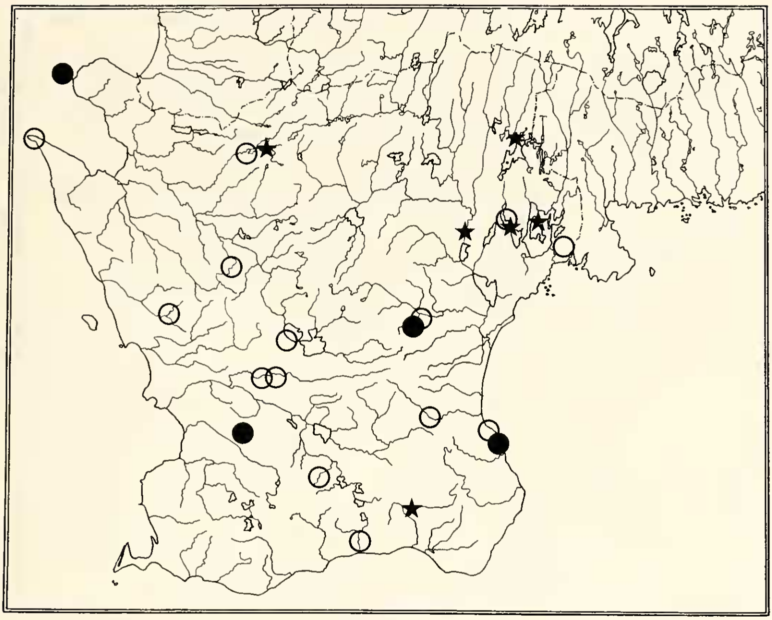
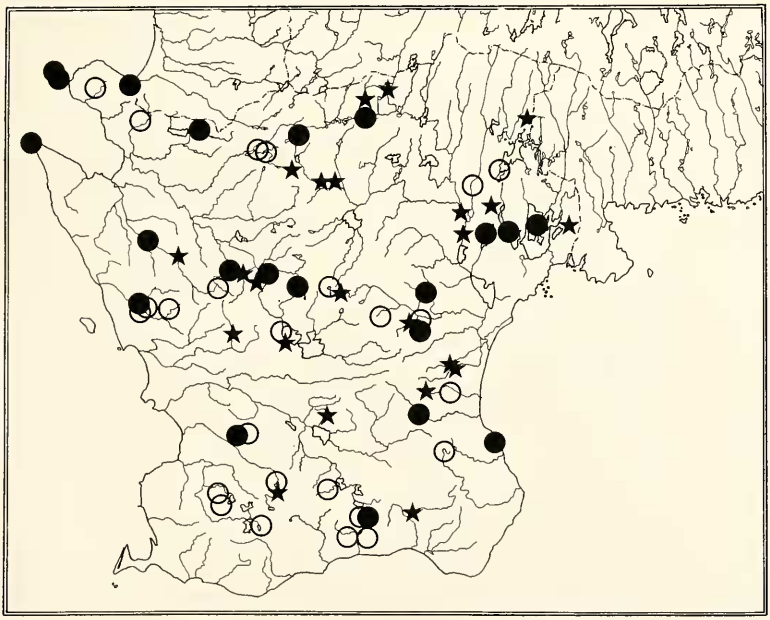
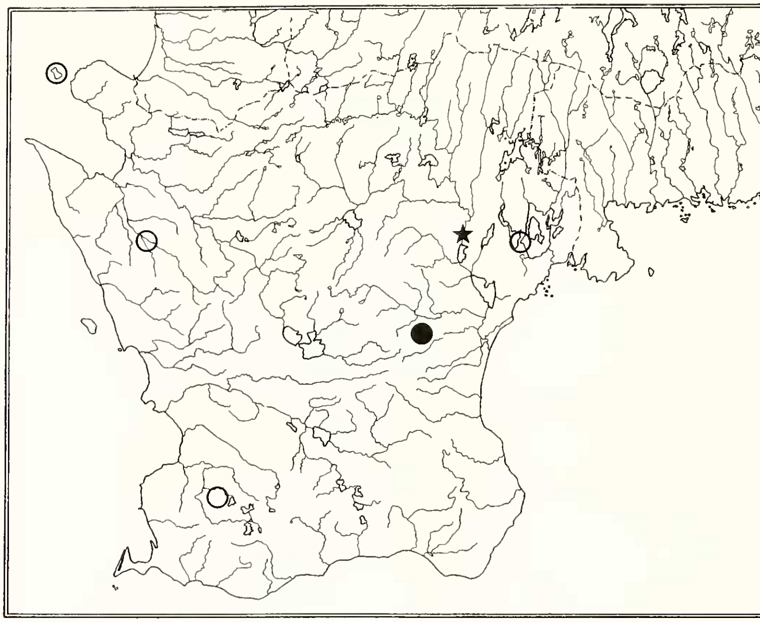
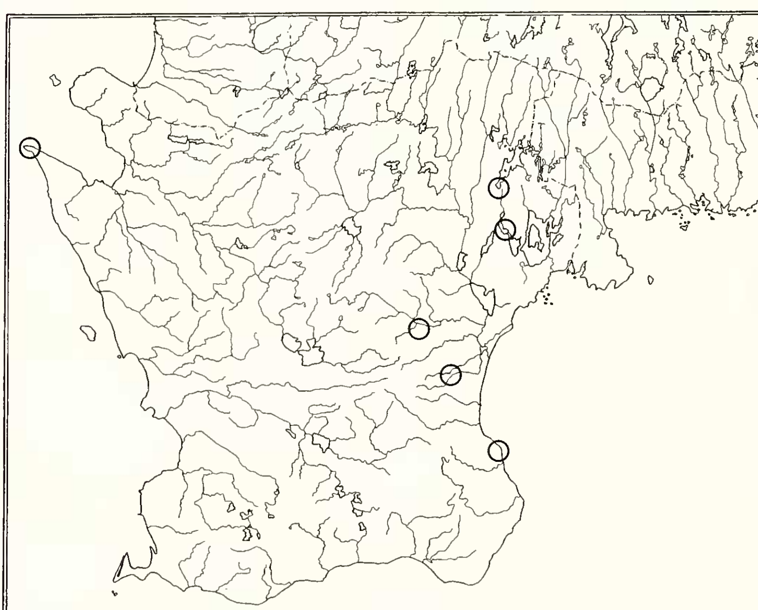




Figs. 7–8. Former and present records of lichen species in Skåne. – 7. (above) *Phlyctis agelaea*; – 8. (below) *Pyrenula nitida*.





Figs. 9–10. Former and present records of lichen species in Skåne. – 9. (above) *Ramalina obtusata*; – 10. (below) *Sticta fuliginosa*.

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Lichen Mapping in Denmark

By Ulrik Søchting, Copenhagen

With 5 figures

Denmark is a small country on the European map, but nevertheless a number of natural distribution limits of lichens lie within the area of this country. This is particularly the case for many epiphytes of beech, e. g. *Enterographa crassa* (Fig. 1). But also epiphytes as *Parmelia laciniatula* (Fig. 2) and *Parmelia revoluta* have their northern limit in Denmark and in the southern parts of Sweden.

Some terrestrial lichens such as *Cladina stellaris* and *Cladonia bellidiflora* are at their limit of distribution in Denmark.

In recent years Denmark and Schleswig-Holstein have attained the dubious quality of being the northern fringe of the "Central European lichen desert" (Fig. 3). The frequency of many lichens has decreased dramatically during this century.

Lichens at their natural distribution limit are often rare and vulnerable. A recent Danish red list of lichens (Alstrup & Søchting 1989) thus lists 88 of the about 900 recorded Danish lichens as extinct and about 220 to be endangered or vulnerable. There is thus an urgent need for increased surveillance and improved measures to protect sensitive lichen rich habitats.

In Denmark such habitats are old trees in ancient woodland, road side trees, twigs, lichen-rich heathland and dunes, and stone fences. Primary threats are increased woodland management, air pollution and shading due to decreased grazing.

In order to identify changes in lichen distribution baseline distribution studies are a prerequisite. Fortunately there has been a tradition for such studies in Scandinavia, primarily carried out by Swedish lichenologists (Degelius 1935, Almborn 1948, Hasselrot 1953). The Danish lichenologist Paul Gelting mapped the occurrence of about 100 Danish lichens during the thirties and fourties. However, none of these maps were published.

Subsequent mapping has focussed on specific genera (Alstrup 1978), certain interesting species (Baldursdottir et al. 1982, Søchting & Christensen 1989) or the lichens of particular substrates, e. g. road side trees (Fig. 3). (Søchting & Ramkær 1982).

Recent mapping studies in Denmark include a fourth remapping of epiphytes in Copenhagen (Søchting & Ramkær 1987) and remapping of epiphytes on countryside road-side trees (Søchting 1989).

Distribution data for Danish lichens have previously not been stored in a standardized way so they can be accessed by other persons, and no computer programs have been available for preparation of distribution maps. In recent projects, however, data are stored in dBASE files.

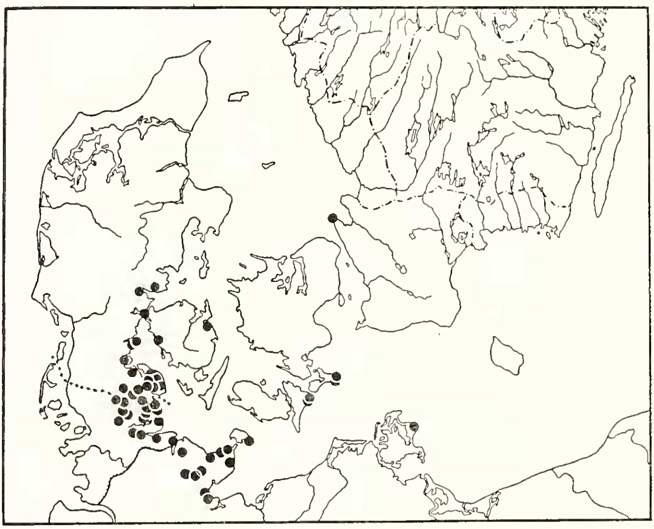
Denmark has no national grid system, but UTM is indicated on the ordnance survey maps and as blue print on special maps (Fig. 4). Undoubtedly future mapping in Denmark will be based on the UTM grid system.

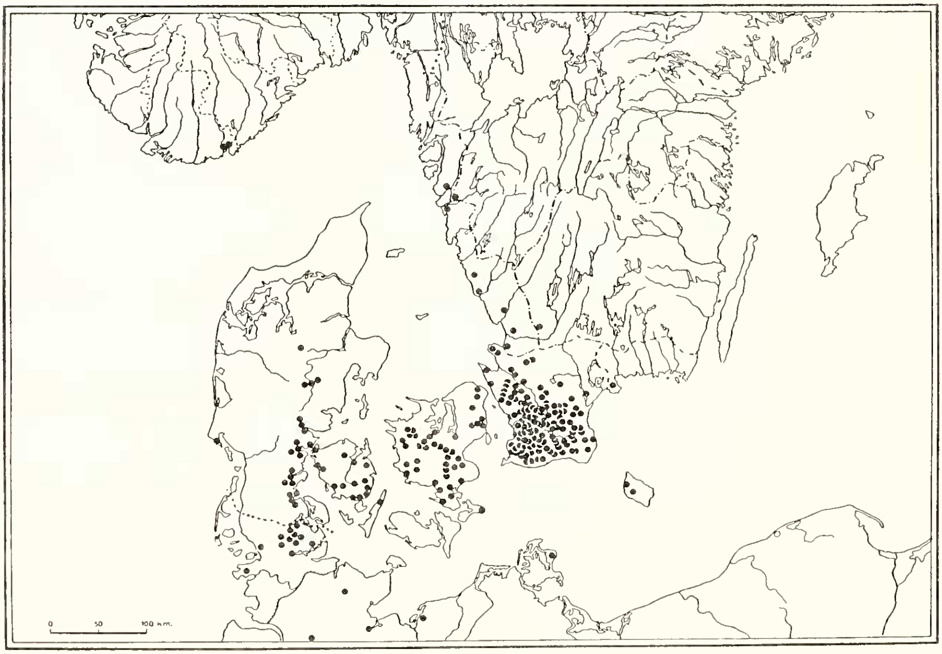
There is an urgent need for a formalized way of storing data on occurrence of lichens. However, it is important that this can be done with a minimum of labour, as

the data may not readily lead to conclusions or publications, and very little immediate scientific credit is associated with the effort.

It is highly desirable that national data can be transformed to cover a European scale, which means that a variety of quadrat sizes can be used, e. g. 10, 25, 50 km.

Mapping is a laborious task. This can be illustrated by a recent example, which can serve as a warning. It was decided at the first meeting of the Nordic Lichen Society in





Figs. 1–2. Distribution of 2 lichen species in southern Scandinavia (from ALMBORN 1948). – 1. (above) *Enterographa crassa*; – 2. (below) *Parmelia laciniatula*.

1975 to initiate mapping of *Lobaria pulmonaria* in the Nordic countries. Only after a substantial effort a map of this single species was presented at the meeting in 1985 (Fig. 5).

I think a prudent initial approach to European lichen mapping would be to establish a common frame to be used by mappers, who for different personal reasons are interested in specific taxonomic groups or ecological problems. Such a frame, which should be compatible with national databases, could make it possible for professional as well as amateur lichenologists to supply data to colleagues in other countries, and could eventually result in coordinated European mapping of species of particular interest.

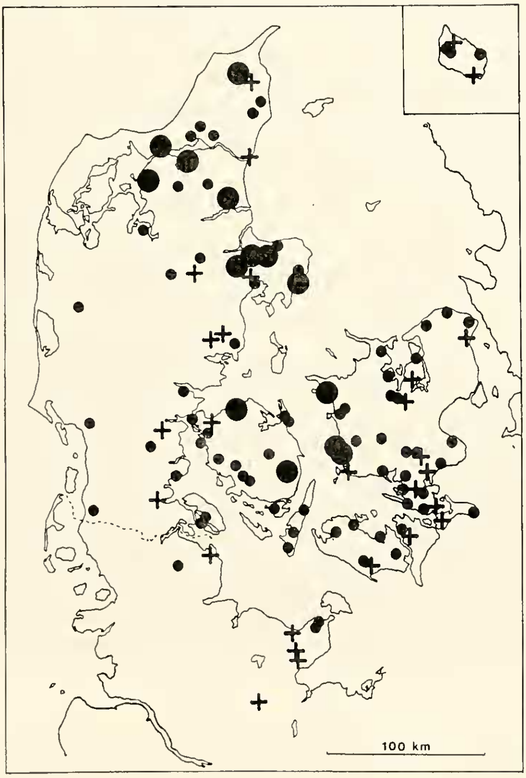


Fig. 3. Occurrence and vitality of *Anaptychia ciliaris* in Denmark and Schleswig-Holstein. – *Big dot*: Fertile specimen; *small dot*: healthy, sterile specimen; *cross*: unhealthy specimen.

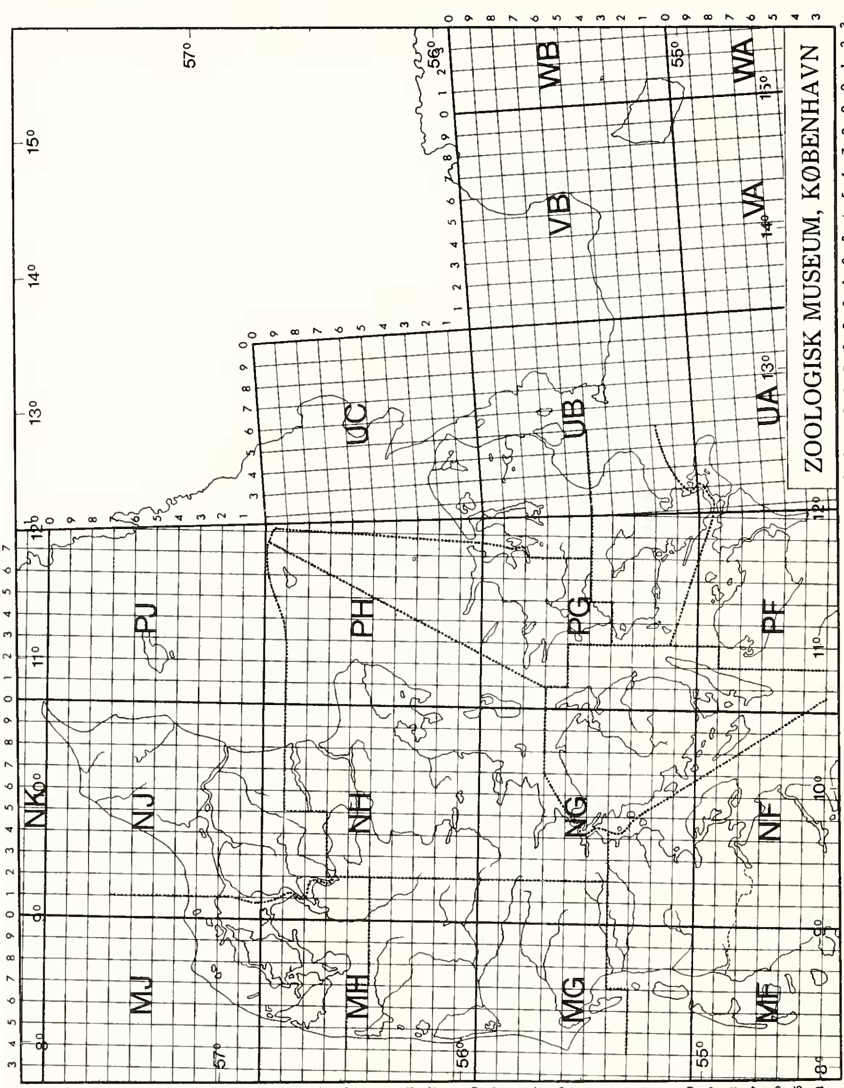


Fig. 4. UTM-grid map of Denmark.

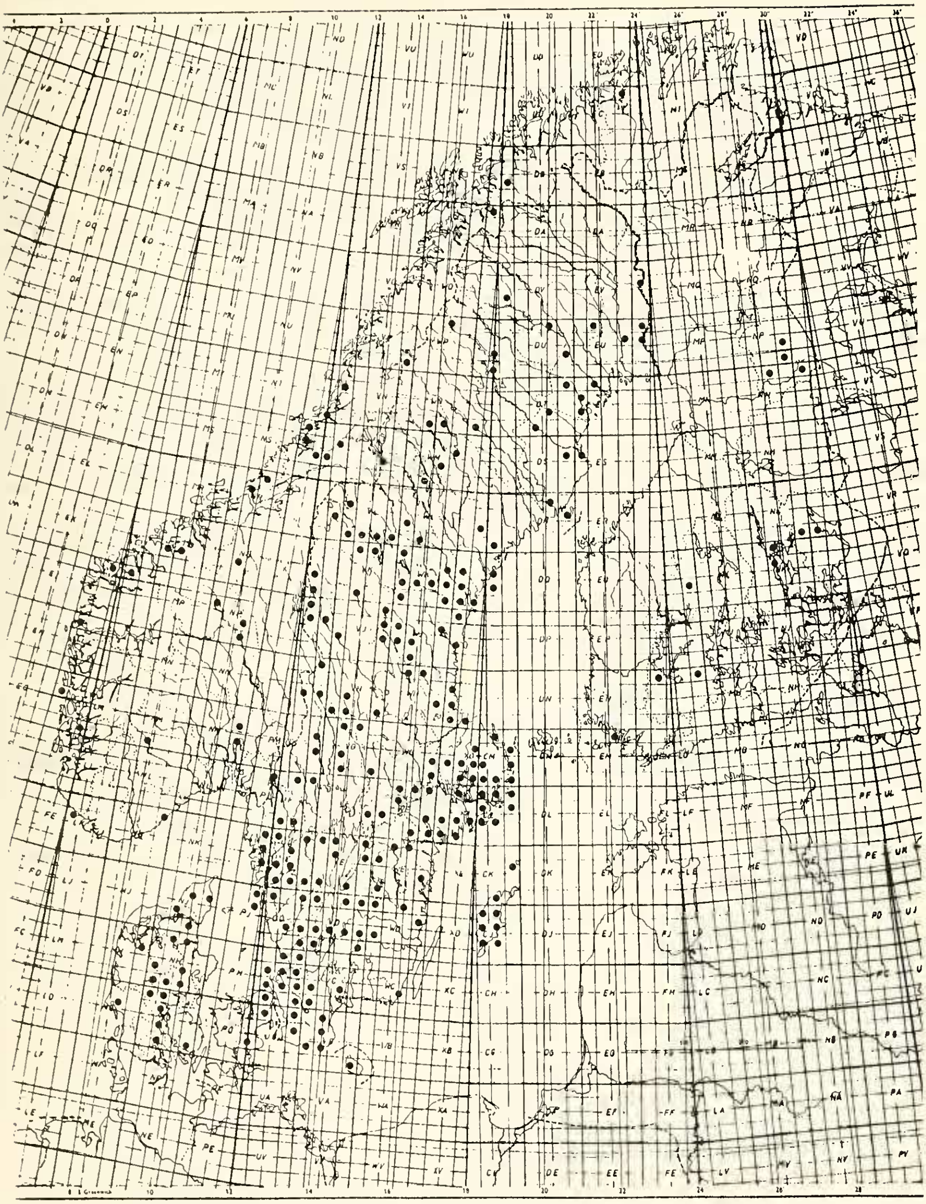


Fig. 5. Distribution of *Lobaria pulmonaria* in the Nordic countries. Compiled for the Nordic Lichen Society in 1985 by P. M. JØRGENSEN, R. MOBERG, U. SØCHTING & O. VITIKAINEN.

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Mapping of Threatened Lichens in USSR and General Considerations on a European Project

By Hans Trass, Tartu

With 3 tables

1. Lichen mapping of threatened species in USSR

Among the variety of living organisms, lichens probably are the most sensitive ones to environmental changes. We don't know exactly how many species we have lost already in total (may be some hundreds, or one thousand?), but regional losses are partly known. In Estonia, a small country on the Baltic seashore (45 100 km^2) with a lichen flora of about 700 species, 15 species have become extinct during the last 40 years and approximately 150 species are endangered (Trass 1978, 1984; Trass & Randlane 1983, 1986, 1987).

The number of species registered in the Red Data Books (RDB) of different countries can be taken as an indicator of the degree of endangerment of the lichen flora. In some countries a great number of species has been included in RDB. In Germany this number is 288 (Wirth 1978), in Sweden 214 taxa have been classified according to national red data categories (FLORAVÅRDSKOMMITTEN 1987): 17 vanished species, 46 endangered, 30 vulnerable, 102 rare, 19 care-demanding. In Finland 79 species are included in the list of threatened species (10 extinct, 13 severely endangered, 13 endangered, 26 care-demanding) (Koistinen et al. 1986). In the USSR the second edition of RDB which was published in 1984 includes 29 species (Table 1) of macrolichens out of approximately 3500 species of the whole flora.

Table 1. Threatened lichen species in the RDB of USSR (2nd ed. 1984).

Asahinea scholanderi	*L. pulmonaria*
Aspicilia oxneriana	*Parmelia borisorum*
Bryoria fremontii	*P. mougeotii*
Cetraria alvarensis	*Pyxine endochrysoides*
C. komarovii	*Ramalina evernioides*
Cladonia graciliformis	*R. maciformis*
Cl. vulcani	*Rocella fucoides*
Coccocarpia cronia	*Stereocaulon saviczii*
C. erythroxyli	*Sticta limbata*
Coriscium viride	*Teloschistes flavicans*
Glossodium japonicum	*Tornabenia atlantica*
Hypogymnia hypotrypella	*Umbilicaria esculenta*
Leptogium corticola	*U. subpolyphylla*
Letharia vulpina	*Usnea florida*
Lobaria amplissima	

All RDB species will be mapped and studied on the base of the recently published special program (TRASS et al. 1988). Actually, the number of threatened species is remarkably greater. Supposing that all species occurring only in a single locality are under certain risk the number of endangered species in USSR would be more than 500. Yet not all rare species are endangered. *Aspicilia oxneriana*, e. g., growing only in two small localities in high mountains without any considerable human influence, is not threatened. The third edition of the RDB of USSR will list c. 100 endangered lichen species (in prep.). Mapping will be concentrated on these species.

Outstanding Russian, Ukrainian, Byelorussian and other lichenologists of the twenties and thirties, e. g. A. ELENKIN, V. SAVICZ, A. OXNER and M. TOMIN paid little attention to the exact mapping of lichen species. The first lichenologist with special interest in this problem was K. A. RASSADINA (1950), a specialist for *Cetraria*, *Hypogymnia* and *Parmelia*. After World War II many lichen species were mapped regionally by a new generation of lichenologists, but very few all-union maps were published. Most interest has been paid to lichen mapping in Ukraine, Latvia and Estonia. In Ukraine M. MAKAREVICZ mapped all 800 lichen species of the Ukrainian Carpathian Mountains (MAKAREVICZ & YUDINA 1982), A. PITERANS (1982) all 480 species of the Latvian lichen flora, and H. TRASS (1968, 1970) all 683 species of Estonia. Altogether, based on a distribution catalogue compiled by the Department of Botany and Ecology at Tartu University (Estonia), approximately 100 distribution maps of all-union species, and 1100 regional maps, covering e. g. Chukotka, Southern Far East, Lake Baikal Region, Central Asia, Caucasus, Ukraine, Latvia, Estonia, are available.

There exist no special lichen mapping projects in the USSR. Only the editorial board of the RDB is planning mapping for all RDB species.

In spite of this situation there are many lichenologists in the USSR who are interested in lichen mapping and capable to cooperate in European lichen mapping projects.

2. General considerations

In order to start an internationally coordinated mapping of lichens of Europe we must come to an agreement determining the general principles of the program, including the selection of species, which are to be considered. My suggestions concerning this topic are:

(1) In order to start a coordinated European mapping of lichens we shall have to organize specialists from all European countries.

(2) It is necessary to establish a European Lichen Mapping Committee (ELMC) with subcommittees (of data collection, map compilation, taxa supervision, perhaps one coordinating Eastern European studies, etc.), which would coordinate all mapping activities. Of course, this committee would work in close contacts with the International Union for Conservation of Nature and Natural Resources (IUCN), Threatened Species Committee, Lichen Subcommittee. The main tasks of this committee would be:

(a) to sketch the basic mapping methods and the processing of records for the data-transfer sheets by computer programs (SEAWARD & HITCH 1982);

(b) to decide about the basic mapping grid system. I think, that there should be three grid levels: local (10 km x 10 km), regional (50 km x 50 km), and comprehensive (100 km x 100 km);

Tab. 2. Groups of threatened lichen species in Estonia (examples)

Threatened species groups		Habitat types A		B		C	
		Natural habitats without noticeable human influence		Seminatural habitats with moderate human influence		Urban and industrial habitats with strong human influence	
I	Vanishing species (some occur in single localities with reduced vitality)	IA	*Heterodermia speciosa, Parmelia subrudecta*	IB	*Cladonia brevis, Bryoria bicolor, Parmelia sinensis*	IC	*Alectoria sarmentosa*
II	Severly endangered	IIA	*Usnea glauca, U. articulata*	IIB	*Parmelia caperata, Usnea glabrata*	IIC	*Parmelia acetabulum*
III	Moderately endangered species	IIIA	*Thelotrema lepadinum, Schismatomma abietinum*	IIIB	*Lobaria pulmonaria, Thelomma ocellatum*	IIIC	*Parmelia tiliacea*
IV	Vulnerable species	IVA	*Hypocenomyce friesii, Cyphelium notarisii*	IVB	*Cetraria cucullata, Menegazzia terebrata, Stereocaulon incrustatum*	IVC	*Endocarpon psorodeum*
V	Care demanding species (occuring in a few localities; rare, relic or endemic species)	VA	*Ramalina siliquosa, Lobaria scrobiculata, Pycnothelia papillaria*	VB	*Cetraria alvarensis, Opegrapha ochrocheila, Peltigera venosa*	VC	*Pertusaria hemispaerica*

(c) to form an active, busy and competent "European mapping team";
(d) to organize special mapping excursions, to guarantee the recurrent mapping of selected species groups (after each 10?, 15? years);
(e) to compile the species list proposed for mapping, taking into account and discussing the proposals coming from different countries and lichenological centres;
(f) to organize the technical processing of data and publishing of generalized maps.

(3) A very important task is to compile a preliminary list of species of interest. This list should not be too long. It may consist of one to two hundred species. If work starts successfully, new species may be added.

(4) It is suggested that greatest attention should be paid to the vanishing and endangered species. For instance, the 150 species of the lichen flora of Estonia which need protection, are divided into five main groups and 15 subgroups. The main

Table 3. North European threatened lichens species common for Sweden, Finland and Estonia. – *0* = vanished, *1* = endangered, *2* = vulnerable, *3* = rare, *4* = care-demanding.

Species	Sweden	Finland	Estonia
Bryoria bicolor	4	2	0
B. nadvornikiana	3	1	1
Cetrelia olivetorum	1	2	0
Chaenotheca coniophaea	3	4	1
Cladonia incrassata	3	1	1
Collema subnigrescens	4	1	3
Coniocybe farinacea	4	4	1
Cyphelium notarisii	0	4	1
Evernia divaricata	2	4	3
Gyalecta ulmi	4	4	1
Heterodermia speciosa	1	2	0
Leptogium cyanescens	2	4	1
L. rivulare	1	0	1
Menegazzia terebrata	2	2	4
Nephroma laevigatum	4	2	2
Parmelia caperata	1	0	1
P. tiliacea	3	2	3
Ramalina calicaris	4	4	4
R. obtusata	4	4	3
R. sinensis	3	4	4
R. thrausta	1	2	1
Stereocaulon incrustatum	3	4	4
Usnea longissima	1	0	0

attention is being paid to the groups I–III and to subgroups C of each group (Table 2).

(5) The success of lichen mapping depends on some important practical problems. Detailed maps showing areas where endangered species concentrate are indispensable for organizing of special lichen reserves. In Estonia we have founded two lichen microreserves, one with *Cetraria cucullata* on the Isle of Vormsi, another one on the Isle of Saaremaa with rich xerocontinental Alvar flora. The establishment of two further areas is under progress.

3. Conclusions

I made an attempt to compare the threatened species lists of three Northern European countries, i. e. Sweden, Finland and Estonia. Altogether there are 352 species in these lists. Only 23 species (Table 3) are included in the lists of threatened species of all three countries. There are 43 species common to the lists of Sweden and Estonia, 39 to the lists of Sweden and Finland and 33 to the lists of Finland and Estonia. If we seek for a criterion for a compilation of European lists, we could start with those species considered to be threatened in the highest number of countries. For this purpose we have to compile a comparative list of all European countries having lichen RDBs and select the most common species. There may, of course, arise difficulties as the

lists of different countries are based on varying theoretical and methodical approaches.

Finally, I hope that an era is over for now and ever, during which „Europe" ended at the western borderlines of Poland, Czechoslovakia and Hungary, and that the scientific isolation of Northern and Eastern European states, especially the one of those incorporated in USSR as Estonia, Latvia and Lithuania, is broken for all times. We shall join the free European scientific community with real hunger for true scientific contacts.

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Lichen Mapping in Poland

By Wiesław Fałtynowicz, Gdynia

Research on the lichen flora of Poland has started in the beginning of the 19th century. Earliest studies of major significance were made by German lichenologists, e. g. Körber, Flotow, Stein and Ohlert. The first Polish contributors to lichenology in the twenties of this century were Motyka, Sulma and Krawiec. Until 1950 only a few small regions were covered by detailed descriptions of the lichen flora. A more dynamic development in lichenological studies was initiated by Tobolewski forty years ago. Although a number of about 20 lichenologists are working in Poland at present, the state of knowledge of the lichen flora of many regions remains insufficient. The lack of data from Central and South-Western Poland is particularly obvious. The best studied areas are situated in the southern, eastern and northern parts of Poland.

Lichen mapping in Poland was started by Tobolewski twenty years ago. Since 1971 9 volumes of the "Atlas of the geographical distribution of spore plants in Poland – series on lichens" were published. The next volume is in press. Each volume comprises distribution maps of ten lichen taxa.

In 1984 the author decided to start work on an "Atlas of the geographical distribution of lichens in Poland" after a long discussion with Prof. Tobolewski. A grid system of 44 grids of 100 km x 100 km and 3137 grids of 10 km x 10 km was chosen. The central line of this grid system is identical with 19° eastern longitude. This system has been used by botanists of the Institute of Botany at the Polish Academy of Sciences for the mapping of vascular plants for many years. Unfortunately, the grid system adopted does not correlate with the one applied in the "Atlas Flora Europaea" project.

According to the "Preliminary Checklist of Polish lichens" (Fałtynowicz, unpubl. manuscript), 1420 lichen taxa have been recorded on the Polish territory until now. About 20% of them have not been recorded again after 1945. Almost all published as well as many unpublished data on Polish localities of lichen taxa have been compiled by the author. Herbarium collections are regarded only to a small extent. Additionally, taxonomical revision of herbarium material dating from the 19th and from the beginning of the 20th century is obligatory. Until now, about 300 distribution maps of lichen taxa in Poland have been prepared.

Although data on the Polish lichen flora have not been completed yet, it can be confirmed that the areas of many lichen species have an eastern boundary on the Polish territory, e. g. subatlantic species as *Buellia aethalea, Lecidea erratica, Pertusaria hymenea* and *Xanthoparmelia mougeotii.* Furthermore, areas of more than 100 taxa show a distinct gap between the northern part of Poland and the mountains in the south. Examples illustrating this fact are *Umbilicaria deusta, Collema flaccidum* and *Mycoblastus affinis.* The reasons for this gap in geographical distribution might be found in postglacial history of vegetation and climate.

The compilation of all obtained data is intended to be completed next year. Obviously, current studies on local lichen floras will result in a supplement and revision of the distribution maps of certain species.

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The Mapping of Lichens in Bohemia: Aims, Problems and Present State

By Jiří Liška, Praha

With 9 figures

Problems resulting from the sensitivity of lichens to environmental changes have been extensively studied in many countries. There are abundant data on distribution of lichens in selected areas surrounding sources of pollution. Yet the situation in larger areas is poorly known and this poor knowledge is very often based on data covering large time intervals. Additionally, the distribution of rare lichens is better known than the one of common species. However, the knowledge of the distribution of common epiphytic lichens and especially of its change in time is very important for monitoring environmental changes. For this reason, projects of mapping the present distribution of lichens were started in some European countries.

In Czechoslovakia, as in the F.R.G. and Austria (Wirth 1984), coordinate grid squares of 10' to 6' were used. This grid is used in Czechoslovakia for the mapping of higher plants, birds and amphibians, too. Mapping was restricted to sensitive epiphytic lichens. We concentrated mainly on common species. In Slovakia mapping of epiphytic lichens started in 1975 (Pišút 1985), in Bohemia and Moravia in 1978 (Anděl & Liška 1978); in both cases records from 1970 onwards were regarded.

A specific problem of Czechoslovak lichenology is the discontinuity of floristic research in the western part of the country. Systematic investigation was very intensive at the end of the 19th century and in the first decades of the 20th century. Active research of almost a whole generation of lichenologists (F. Kovář, E. Bayer, J. Anders, A. Hilitzer) ceased in the twenties and the thirties. V. Kuťák, J. Podzimek, J. Suza and M. Servít finished their work in the fourties and fifties. A lack of amateur lichenologists as well as a specialization of some lichenologists on studies on the eastern parts of Czechoslovakia resulted in a scarcity of data on the actual distribution of many lichens. Furthermore, lichenology in Czechoslovakia has been officially declared to be a nonperspective field of research and has not been financially supported therefore.

The whole area of Bohemia and Moravia comprises 679 grid-squares. The mapping project in Bohemia and Moravia was started by me together with P. Anděl who, however, withdrew later. Hence, field investigations have not proceeded as fast as, e. g., in Austria (Türk & Wittmann 1984) and the F.R.G. (Wirth 1987). In order to get satisfactory maps as soon as possible, I decided to concentrate my mapping efforts on the western part, i. e. Bohemia. Despite the problems mentioned above, a large part of Bohemian territory is finished at present. Only a small part in the north and a few scattered grid-squares have not been mapped yet (Fig. 1).

The distribution maps are the basic result of the grid mapping. These maps can be used in various ways. For example, knowledge of the present distribution of some lichen species (Figs. 2 and 3) was used in the Red Data Book of the Czechoslovak fauna and flora. Furthermore, working in large areas makes it possible to demon-

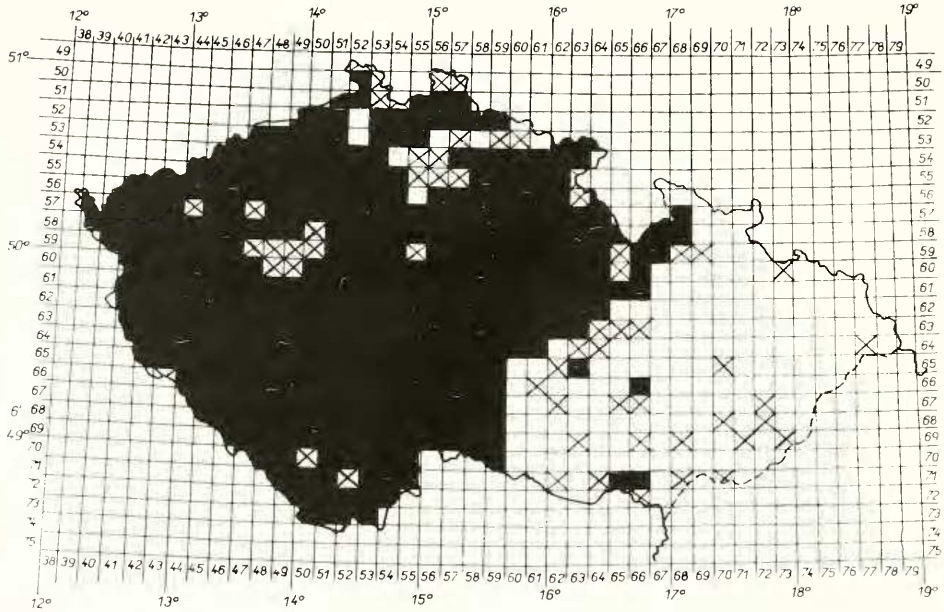

Fig. 1. The present state of lichen mapping in Bohemia and Moravia. – *Crossed grid squares* have not been completely investigated yet.

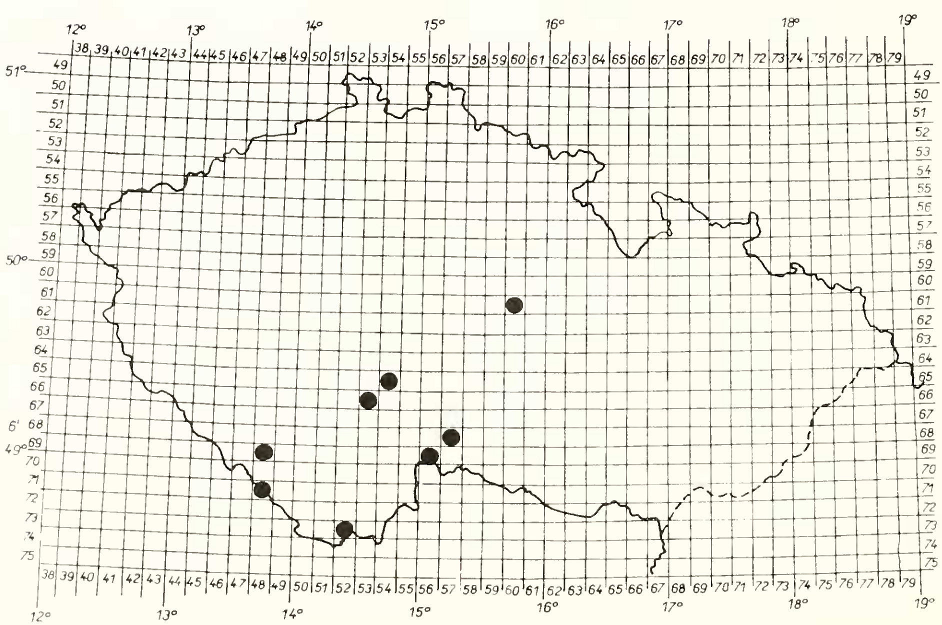

Fig. 2. Preliminary distribution of *Anaptychia ciliaris* in Bohemia after 1970.

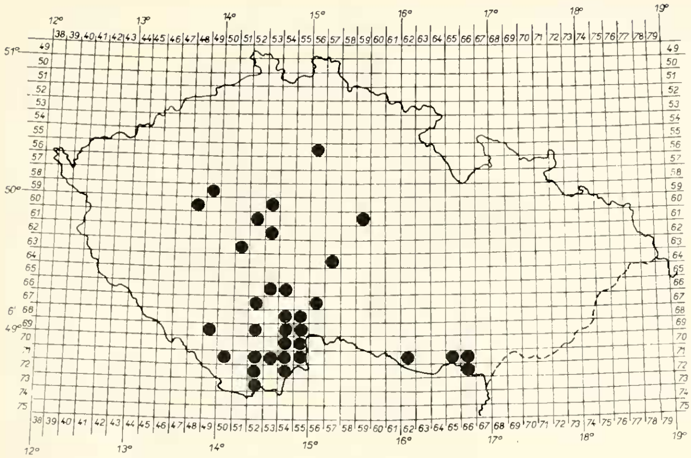

Fig. 3. Distribution of *Parmelia caperata* in Bohemia and Moravia after 1970.

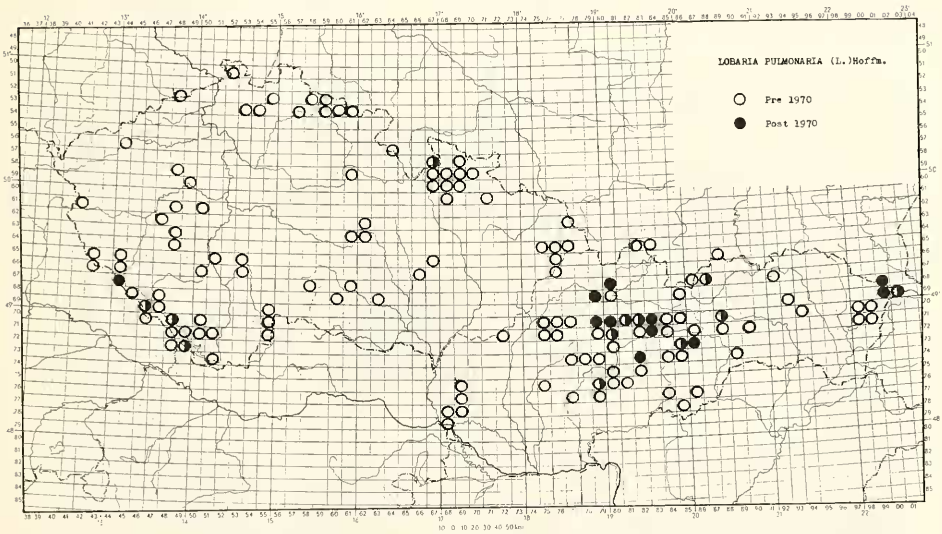

Fig. 4. Changes in the Czechoslovak distribution of *Lobaria pulmonaria*.

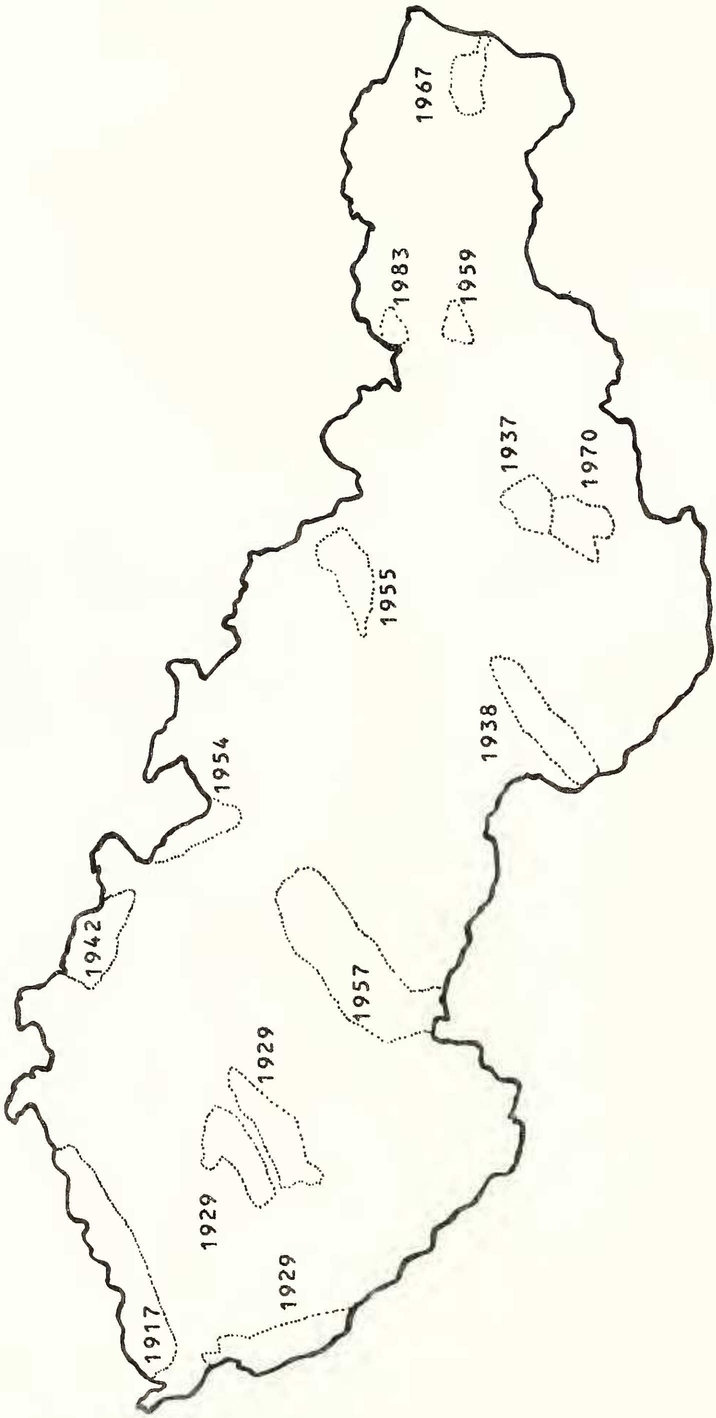

Fig. 5. Date of last records of *Lobaria pulmonaria* at sites where it is now extinct.

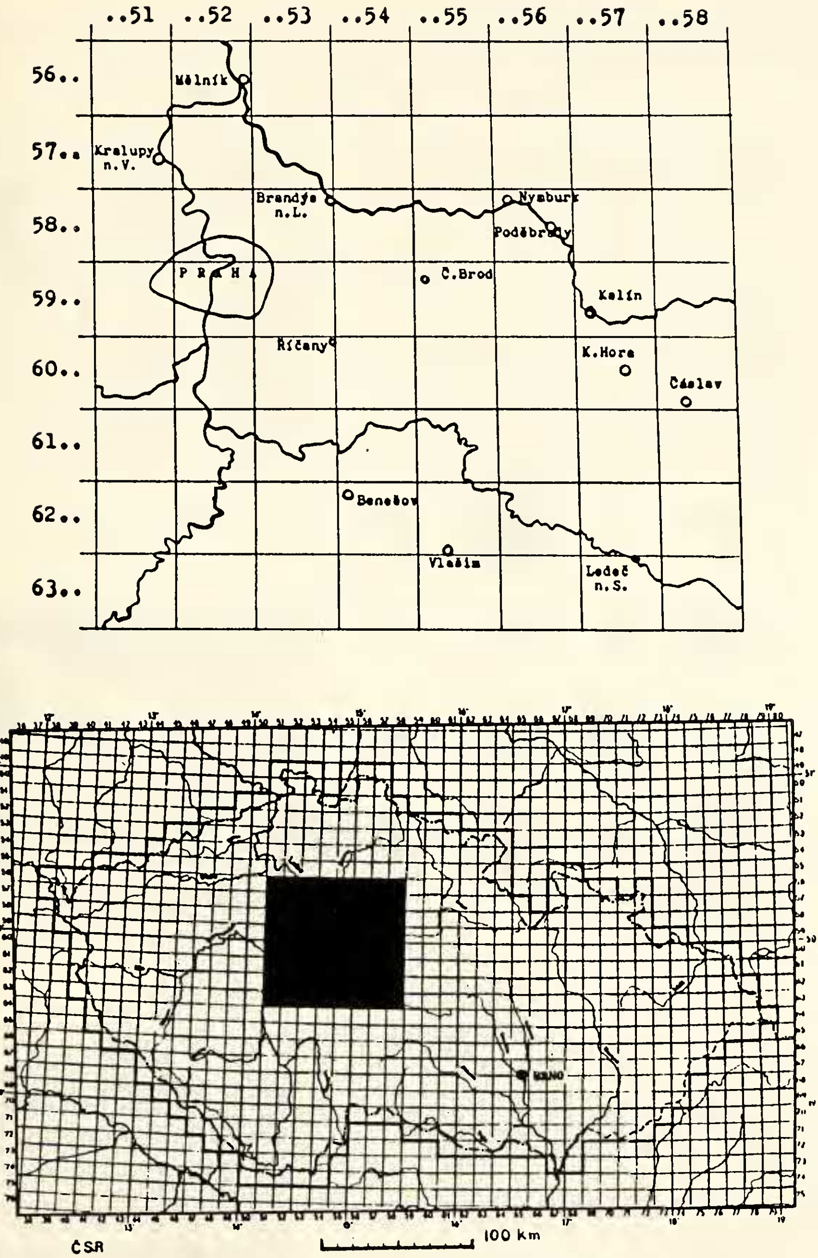

Fig. 6. Investigation area in central Bohemia.

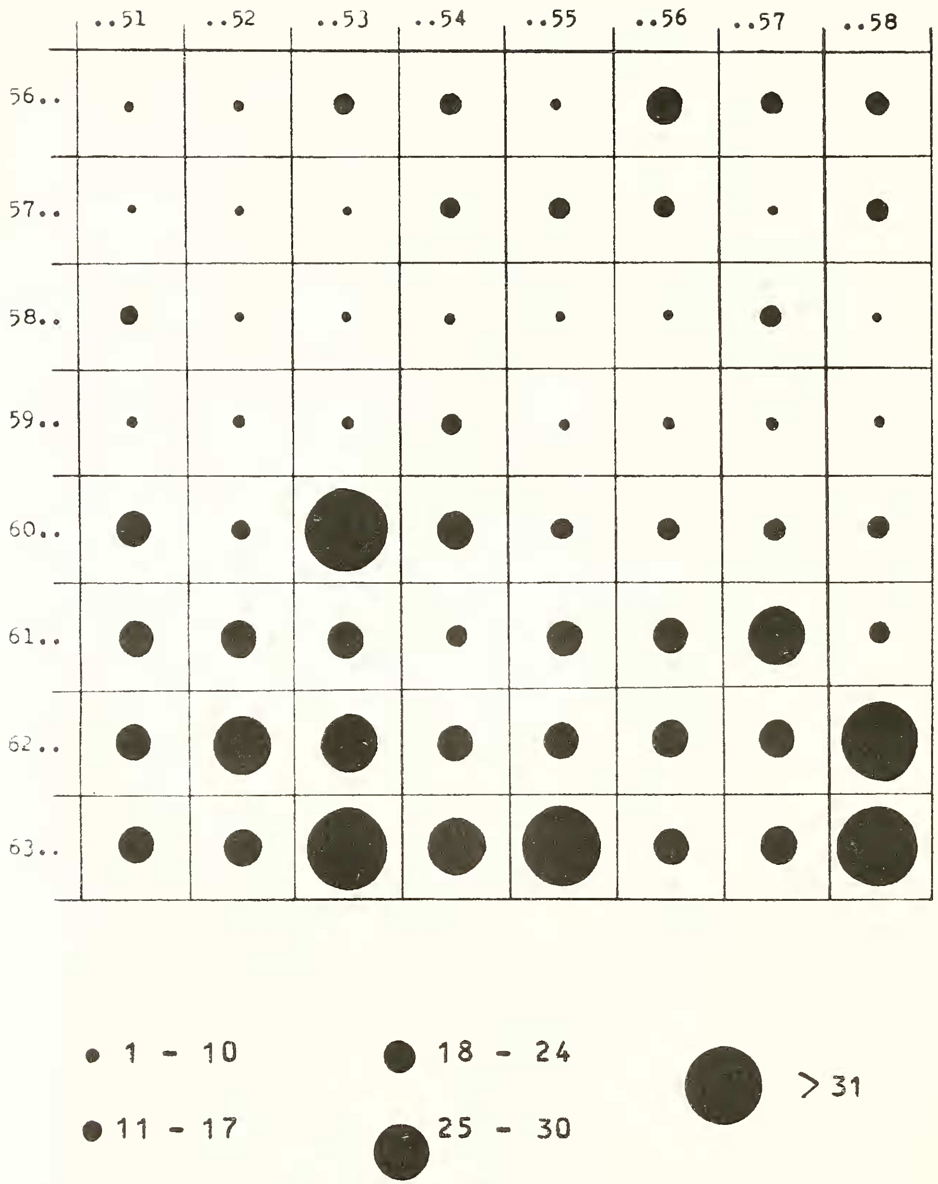

Fig. 7. The total number of epiphytic lichen species per grid square in the investigation area.

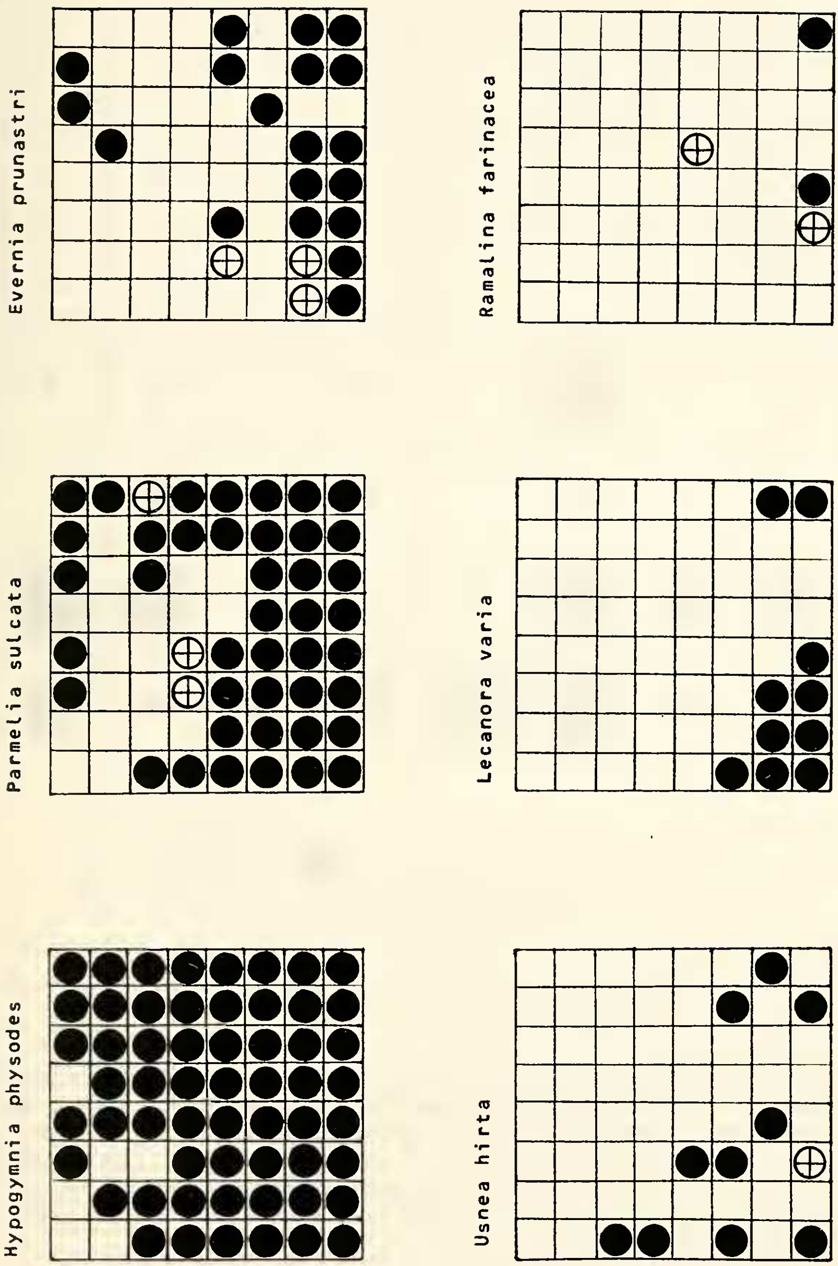

Fig. 8. Distribution maps of species of different bioindicative value. – Area see fig. 6.

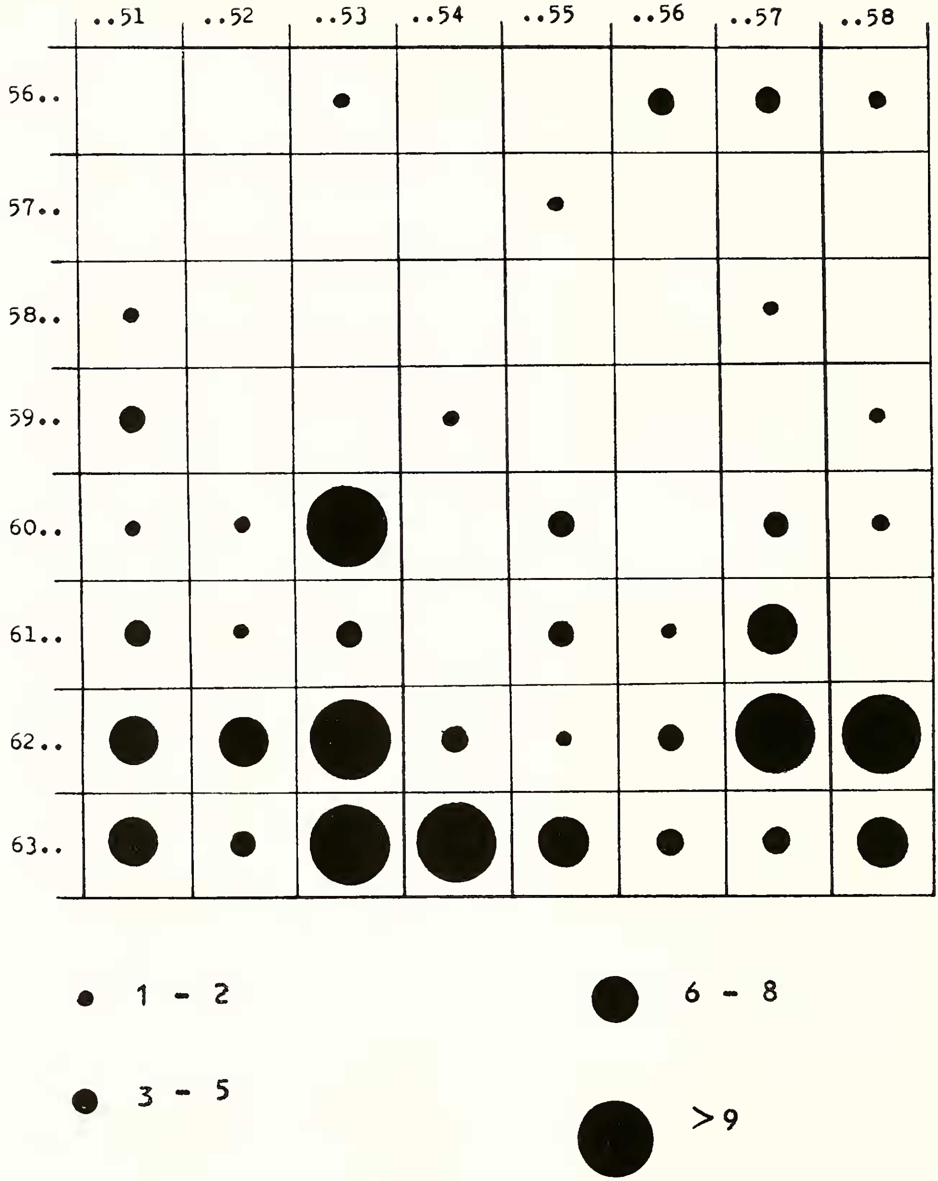

Fig. 9. The total number of selected bioindicator species in grid-squares (air pollution impact evaluation). – Bioindicator species considered: *Bryoria fuscescens, Candelaria concolor, Cetraria chlorophylla, Evernia prunastri, Hypogymnia tubulosa, Lecanora varia, Parmelia acetabulum, P. caperata, P. subrudecta, P. tiliacea, Pertusaria albescens, P. amara, Physcia stellaris, Physconia distorta, Platismatia glauca, Pseudevernia furfuracea, Ramalina farinacea, R. fastigiata, R. fraxinea, R. pollinaria, Usnea* cf. *hirta, Xanthoria polycarpa.*

strate effects of various factors operating at larger scales (e. g. climate, altitude, substrate), among them landscape deterioration. Also air pollution impact is of great importance. This will be treated in detail in the contribution by I. Pišút (this vol.). By comparing distribution maps we can distinguish species with different degrees of sensitivity. This enables us to define a scale of bioindicators.

Regarding the time factor allows to extract much more information from the maps. The changes in distribution are enormous, especially in many epiphytic lichens. *Lobaria pulmonaria* was selected as an example to demonstrate such changes (Liška & Pišút 1990). This species is very conspicuous both in size and morphology; thus it might be assumed that it has been collected more frequently than other species and therefore more data (published records and specimens in herbaria) are available for reconstruction of its former distribution (Fig. 4). *Lobaria pulmonaria* was formerly common in all mountain regions of Czechoslovakia. Nevertheless, beginning with the end of the nineteenth century its decline was recorded by various authors (Zahlbruckner 1894, Los 1928, Anders 1935). Interesting data (Fig. 5) are provided by the last records of this lichen in mountains of western parts of Czechoslovakia (in which it is extinct now):

1917 – Krušné hory
1929 – Český les, Křivoklátsko, Hřebeny a Brdy
1942 – Krkonoše
1955 – Beskydy
1957 – Českomoravská vysočina.

Obviously, there is a correspondence of this sequence with a degree of deterioration of these regions today. It is interesting that sparse data recorded in the earliest period of lichenological research exist even from the most polluted Krušné hory-area. In central Bohemia *L. pulmonaria* vanished in the thirties.

Correspondingly, the last records of this species in mountains of Slovakia give a similar picture (Fig. 5):

1937 – Kremnické vrchy
1938 – Malé Karpaty
1959 – Slovenský raj
1967 – Vihorlat
1970 – Štiavnické vrchy (only one damaged thallus)
1983 – Belianske Tatry (only one damaged thallus).

Whereas *Lobaria pulmonaria* was recorded from 130 grid squares all over Czechoslovakia before 1970, it occurs in the western part of Czechoslovakia only in 5 grid squares and in Slovakia only in 18 grid squares. In almost all of these cases the thalli are visibly damaged.

Data sets obtained by the mapping can further be exploited for large scale bioindication applying an approach in which each grid square is evaluated both on the basis of quantity (number of recorded species) and quality (bioindication value of each species) (Liška 1989). An example of such large scale bioindication for an area in Central Bohemia is presented in Fig. 6.

The total number of epiphytic lichens gives a rough image of the situation (Fig. 7). However, not all species have an identical bioindicative significance. Using distribution maps of selected bioindicators of different sensitivities (i. e. a qualitative scale), we get a picture of air pollution gradients in the landscape (Fig. 8). The total number of species may also be a good indicator. To increase its predictive power we excluded

toxitolerant species, species of wide ecological amplitude and species which are problematic concerning identification; in other words, we used the total number of good indicator species only (Fig. 9). If we compare results based on these different characters, the last mentioned approach provides a good method not only for an evaluation of the epiphytic lichen flora itself, but also for an evaluation of the air pollution impact.

This contribution tried to demonstrate that lichen grid mapping yields valuable results which can be interpreted for various purposes. Furthermore, it provides a base-line for monitoring and evaluating future changes.

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Mapping of Lichens in Slovakia

By Ivan Pišút, Bratislava

With 8 figures

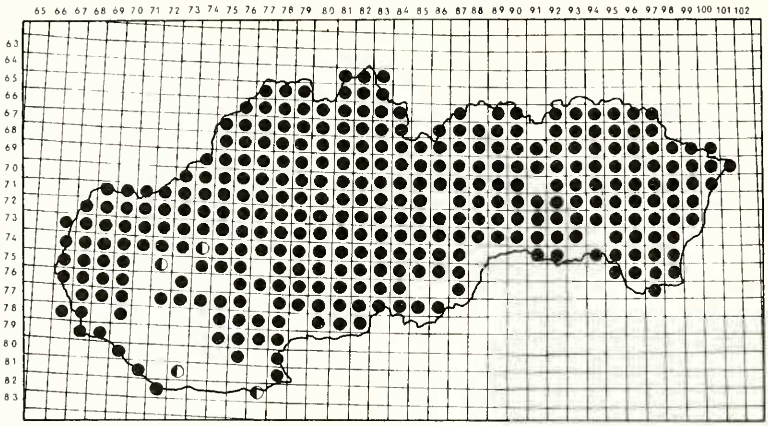
In spring 1975 a small group of persons interested in lichens of Slovakia and inspired by mapping activities in Great Britain, The Netherlands and West Germany were beginning with mapping, too.

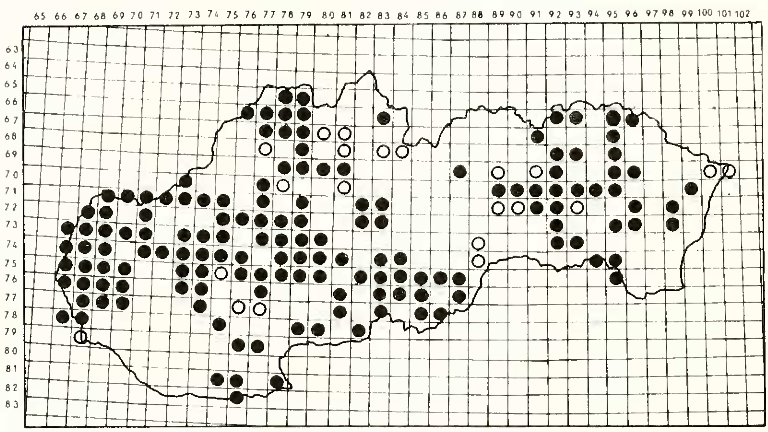
In Slovakia, the eastern part of Czechoslovakia, a discrepancy between the number of participants, c. 5 persons, and the area of the country (49.000 km²) became obvious. Therefore they had to confine the investigation on the actual distribution of the epiphytic lichen flora. It was decided to finish mapping within a period of 5 years. But this seemingly long period turned out to be too short. For that reason also records made from 1970 to 1975 during various investigations were regarded. Until the end of 1979 the aim was almost achieved. A small number of grid squares were still investigated in 1980 and 1981. The recording period of 10, eventually 12 years was a compromise, and the epiphytic lichen flora could not be examined in full completeness. Nevertheless, the results offered an interesting and in some cases surprising insight into the true situation of many species.

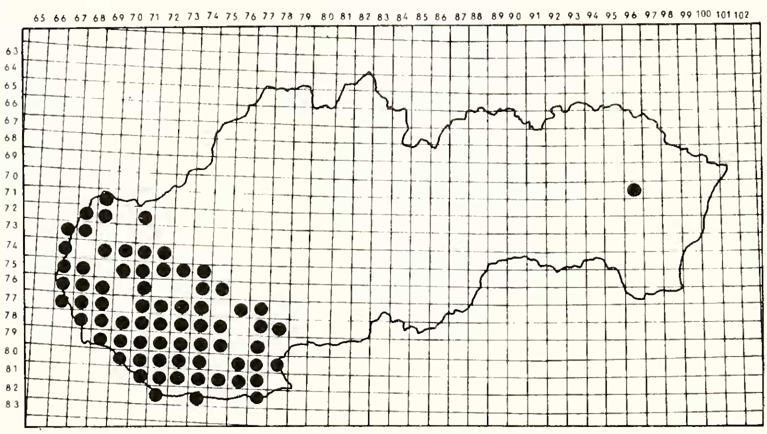
The project being based on voluntary initiative turned out to be a great advantage as no bureaucratic or administrative burden was hindering progress. But such a more or less inofficial teamwork was also connected with some difficulties, especially in the eighties, when participants were short of time in studying herbarium specimens and literature. Therefore only preliminary reports have been published yet (e. g., Pišút 1981, 1985a).

Altogether 374 grid squares were visited. Practically the whole territory of Slovakia, with the exception of some inaccessible squares, e. g. close to the state borderline, was studied. Many formerly not rare species have not been found anymore, e. g. the species of the genera *Conotrema, Hyperphyscia, Sticta,* and the species *Cetraria oakesiana, Collema conglomeratum, C. fragrans, C. nigrescens, Heterodermia speciosa, Leptogium hildenbrandii, Lobaria scrobiculata, Nephroma bellum, Parmelia crinita, P. flaventior, P. revoluta, P. sinuosa, Peltigera collina, Ramalina thrausta* were not confirmed and they are probably extinct. All names of these species were published in the preliminary list of extinct, missing and threatened lichens in Slovakia (Pišút 1985b). Except for the species of *Usnea* and some of *Bryoria,* only about 170 epiphytes were found in the period of 1970–1981.

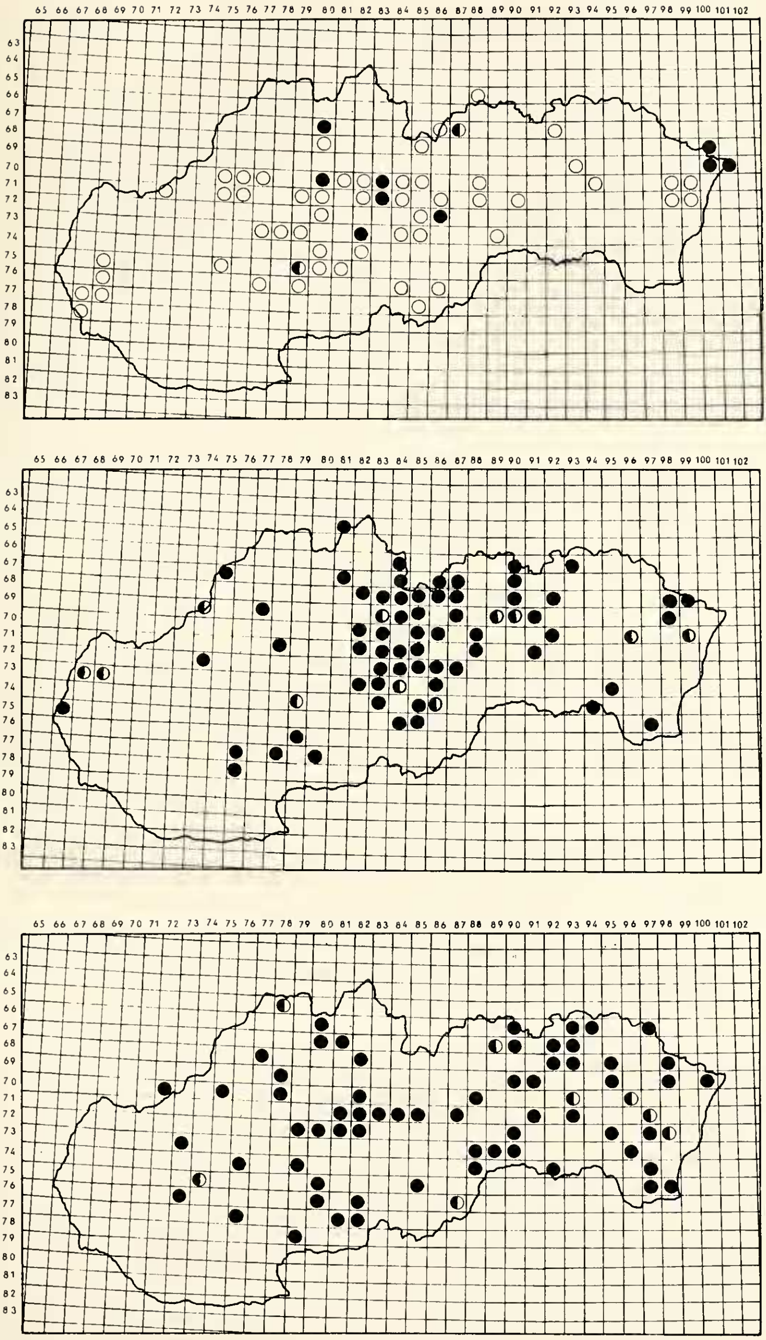
The mapped species were divided into different groups. The first one is represented by species common not only in the past but also in the present. Species belonging to this group are *Hypogymnia physodes* (Fig. 1), *Parmelia sulcata, Evernia prunastri* and others. But also these species of rather high resistance against air pollution declined in the lowland Podunajská nížina in Southwest Slovakia, where a combination of an enormous eutrophication and nitrate pollution occurs; they also disappeared around various pollution sources in other regions. For instance, in Spišská Nová Ves industrial agglomeration *Hypogymnia physodes* has been shown to be



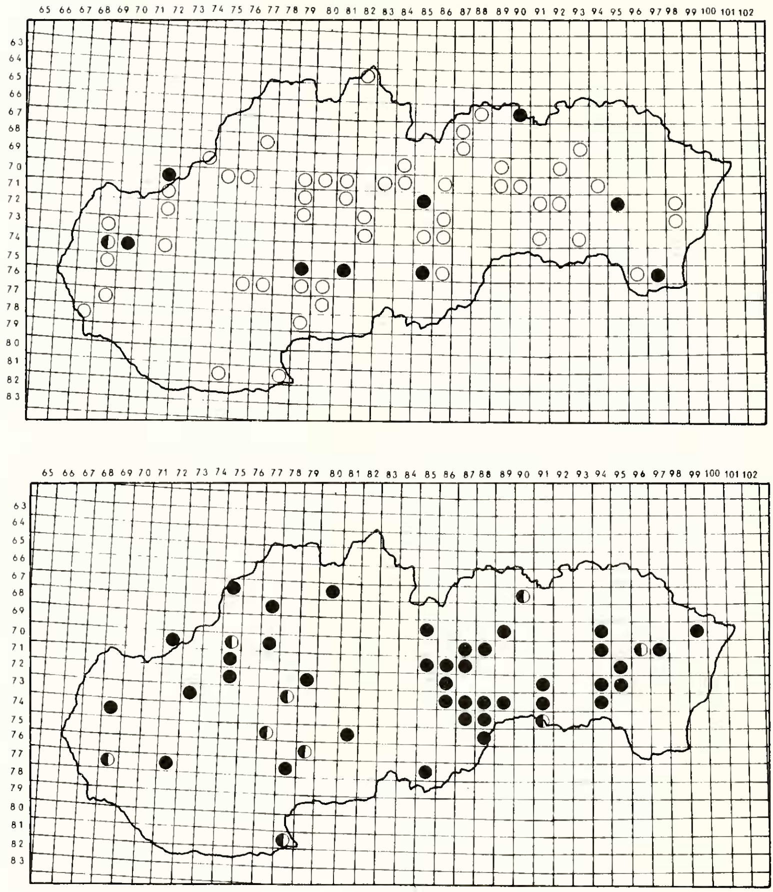




Figs. 1–3. Distribution of 3 lichen species in Slovakia. – 1. (above) *Hypogymnia physodes* (L.) Nyl. (in 1970–1981); *half dots*: only damaged thalli. – 2. *Lecanora conizaeoides* Nyl. ex Crombie; *dots*: 1970–1981, *circles*: 1982 onward. – 3. (below) *Physcia biziana* (Massal.) Zahlbr. var. *aipolioides* Nádv. (in 1970–1981).



Figs. 4–6. Distribution of some lichen species in Slovakia. – 4. (above) *Lobaria pulmonaria* (L.) Hoffm.; *circles*: pre 1970, *dots*: 1970 onward, *half dots*: only damaged thalli. – 5. Species of the genus *Usnea* (1970–1981); *half dots*: only damaged thalli. – 6. (below) *Ramalina fastigiata* (Pers.) Ach. (in 1970–1981); *half dots*: only damaged thalli.



Figs. 7–8. Distribution of 2 lichen species in Slovakia. – 7. (above) *Ramalina fraxinea* (L.) Ach.; *symbols* as in Fig. 4. – 8. *Anaptychia ciliaris* (L.) Koerber (in 1970–1981); *half dots*: only damaged thalli.

extinct in an 300 km² area. Yet, even such a phenomenon had often no visible consequences on the used large-scale grid map (Fig. 1).

The second group is formed by some very remarkably spreading and relatively toxitolerant species. On the one hand there were acidophilous species like *Lecanora conizaeoides* (Fig. 2) or *Scoliciosporum chlorococcum*, both spreading off from polluted areas, and on the other hand nitrophilous ones, concentrated mainly in lowlands with intensive agriculture. Among them a peculiar distribution pattern is shown by *Physcia biziana* (Massal.) Zahlbr. var. *aipolioides* Nádv. (Fig. 3).

The last and largest group is composed by more or less distinctly threatened or declining taxa. First of all there is a number of strongly endangered and threatened species. Most of them are hygrophilous species, restricted to the belt of mountain forests, e. g. *Pachyphiale cornea, Thelotrema lepadinum, Mycoblastus affinis, Lecanactis abietina, Cetraria laureri, Lobaria pulmonaria* (Fig. 4), *L. amplissima, Evernia divaricata, Menegazzia terebrata*.

Less endangered species show two types of decline. They either are occurring mainly in the mountain regions of western and eastern parts of Slovakia as the species of *Usnea* (Fig. 5), *Platismatia glauca*, *Parmelia saxatilis*, *Pseudevernia furfuracea*, or they are occurring mainly in the eastern part of Slovakia, having already become rare in the west, as *Parmelia caperata*, *Ramalina farinacea*, *R. fastigiata* (Fig. 6), *Cetrelia olivetorum*, *Pertusaria albescens*.

What did the mapping reveal? The critical state of the Slovakian epiphytic lichen flora was demonstrated (Fig. 7, 8). An asymmetrical deterioration taking place on the territory of Slovakia was confirmed. Besides the well known influence of short-distance immissions further factors of decline were observed. The surprising regression of epiphytes in Western Slovakia results from an acidification caused either by short or far range pollution combined with effects of modern methods in agriculture and forest management.

Despite international conventions there is little hope for the level of pollutants in Slovakia to sink rapidly in the near future. The proportion of low quality solid fuel – the main source of sulphur dioxide – probably will not decrease significantly in Czechoslovakia, Poland and Hungary. The same holds true for emissions from traffic. Therefore it may be expected that the decline of the majority of epiphytic lichens will even accelerate.

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Lichen Mapping in the Budapest Agglomeration Area (Hungary)

By Edit Farkas, Vácrátót

With 5 figures

1. Introduction

During the last years several lichen atlases of various areas of Europe, mainly from England, Austria, Germany and Poland have been issued (Seaward & Hitch 1982, Türk & Wittmann 1984, Wirth 1987, Cieśliński & Tobolewski 1988). Also valuable papers have been published from other countries of Europe (e. g. Czechoslovakia, France, Spain, The Netherlands). Yet in Hungary just a few papers have been published dealing with this topic; especially air pollution lichen maps were prepared.

At first the lichen map of Debrecen, East Hungary, was prepared by Felföldy (1942). Only ten years ago Gallé (1979) published the lichen map of Szeged, South Hungary, in his last paper before his death. Actually Sernander's (1926) zones were established in both of these cities in the countryside of Hungary.

2. Lichen mapping in Budapest

Our lichen mapping studies were started in Budapest in 1979 (Farkas 1982; Verseghy & Farkas 1984; Farkas et al. 1985). More than 1000 specimens have been collected from 55 sites in Budapest by L. Lökös and the author. The specimens were identified by our tutor, Dr. K. Verseghy.

Four zones of lichen distribution were recognized on the basis of epiphytic lichens. Species occurring in an inner zone are also present in all outer zones (Fig. 1).

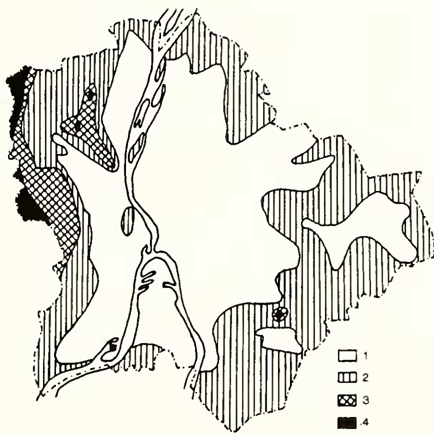
Zone 1: Desert zone

The built-up area of Budapest is in fact a lichen desert without any epiphytic lichens. The boundary of this zone corresponds approximately to the boundary of built-up areas. There was only a small portion of the built-up area, northern Buda, in which lichens were found. Recently we could find some small thalli of *Lecanora hagenii* and *Scoliciosporum chlorococcum* in this zone.

Zones 2 and 3: Struggle zones

Two struggle zones are situated in the outer areas of Budapest. Lichens are present but only a few characteristic species occur. The most resistant crustose epiphytic lichen species, *Scoliciosporum chlorococcum*, *Lecanora conizaeoides*, *L. varia* and *Buellia punctata* are recorded in both struggle zones. We found only little thalli (1–2 cm^2) of the foliose lichens, *Hypogymnia physodes* and *Parmelia sulcata*.

We established an inner and an outer struggle zone on the basis of the occurrence of various *Lecanora* species.



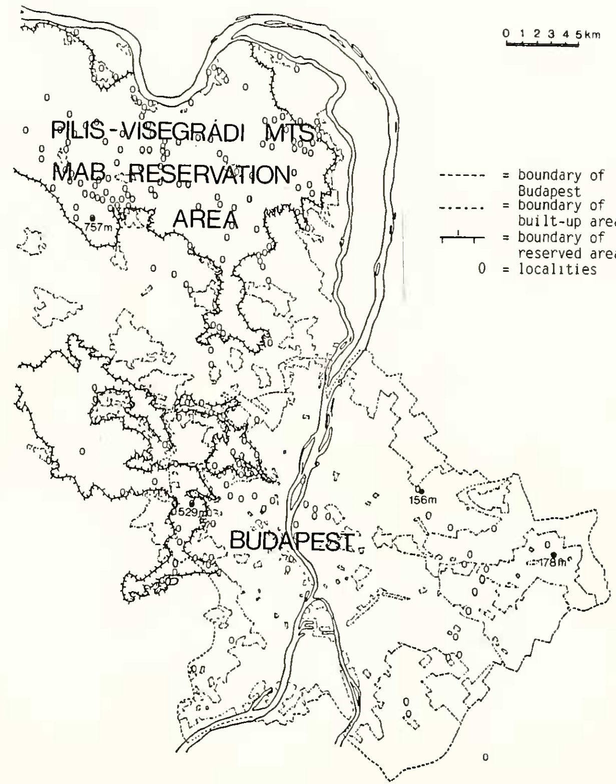


Fig. 1. (left) The air pollution zones of Budapest established on the basis of epiphytic lichen distribution. – *1* = desert zone, *2* = inner struggle zone, *3* = outer struggle zone, *4* = normal zone (FARKAS 1982).

Fig. 2. (right) The investigated area of the Budapest agglomeration.

Zone 4: Normal zone

This is the zone where a more or less natural lichen flora is found. Its area is restricted to a small part of Buda near the western boundary of Budapest. The boundary of the normal zone is determined by the presence of *Parmelia glabratula*.

The most frequent epilithic species of Budapest are *Lecanora muralis, L. dispersa* and *Candelariella vitellina*.

3. Lichen mapping in the Pilis and Visegrádi Mountains

In 1982 research was continued in the Pilis and Visegrádi Mts. NW of Budapest where also a MAB reservation area was established by UNESCO in 1981 (Farkas 1988, 1990, in prep.; Farkas & Lökös in prep.; Farkas & Pátkai in press). It is a typical area of the temperate zone forests covered mainly by *Quercus, Carpinus* and *Fagus* forests. Quercetum petraeae-cerris and Querco petraeae-Carpinetum are zonal vegetation types. The various types of Fagetum occur only extrazonally on northern and north-eastern steep slopes. This woodland is not far from our capital and frequently visited by tourists (Fig. 2).

The area consists of a south-western calcareous rocky part, geologically belonging to the Transdanubian Mts. and a north-eastern siliceous rocky part belonging to the Northern Mts. It mainly consists of andesite and andesitic tuffs. The highest point, the peak Pilis (757 m.s.m.) can be found in the calcareous area.

Until 1988 we had visited 148 localities of the Pilis and Visegrádi Mts. where we collected almost 2000 specimens. We identified and mapped 214 lichen species from various substrata. L. Lökös (Budapest) identified the majority of the *Cladonia, Parmelia* and *Physcia* species. Dr. A. Vězda (Brno) revised our identifications and helped with the most difficult taxa.

Thirteen species are new to Hungary: *Acrocordia cavata* (Ach.) Harris, *Arthopyrenia saxicola* Massal., *Aspicilia excavata* Thor & Timdal (Thor 1988), *Bacidia subincompta* (Nyl.) Arnold, *Biatorella ochrophora* (Nyl.) Arnold, *Caloplaca inconnexa* (Nyl.) Zahlbr., *Cliostomum corrugatum* (Ach.) Fr., *Lecidella timidula* (Th. Fr. & Almq. ex Th. Fr.) R. Sant. comb. inval., *Micarea lithinella* (Nyl.) Hedl., *Rinodina calcarea* (Arnold) Arnold, *R. confragosa* (Ach.) Koerber, *Sarcogyne privigna* (Ach.) Massal., *Strangospora pinicola* (Massal.) Koerber.

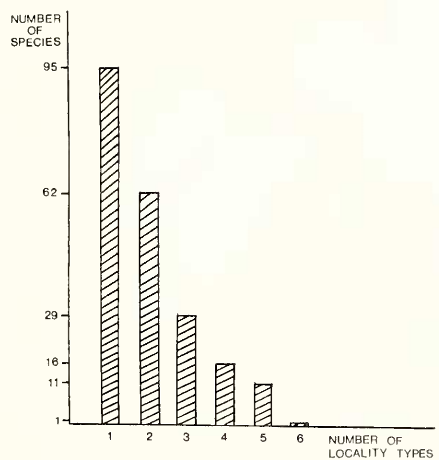
The most frequent species (number of localities in parentheses) are *Lecanora conizaeoides* (120), *Hypogymnia physodes* (98), *Scoliciosporum chlorococcum* (93), *Buellia punctata* (77), *Parmelia sulcata* (70), *P. glabratula* (64).

On the distribution maps we indicated 6 locality types by different marks (see Fig. 4).

One species, *Scoliciosporum chlorococcum*, was collected in all the six locality types (Fig. 3). Eleven species (*Buellia punctata, Candelariella vitellina, Cladonia coniocraea, C. fimbriata, Hypogymnia physodes, Lecanora conizaeoides, L. hagenii, L. muralis, Lepraria incana, Parmelia glabratula, P. sulcata*) were found in five different locality types. The distribution maps provide a bioindication of air pollution. An example is the distribution map of *Lecanora conizaeoides* (Fig. 4).

4. Possibilities of lichen mapping in Hungary

The lichen floristic data collected for air pollution mapping of the Budapest agglomeration area and the MAB reservation area form a good basis to start grid mapping



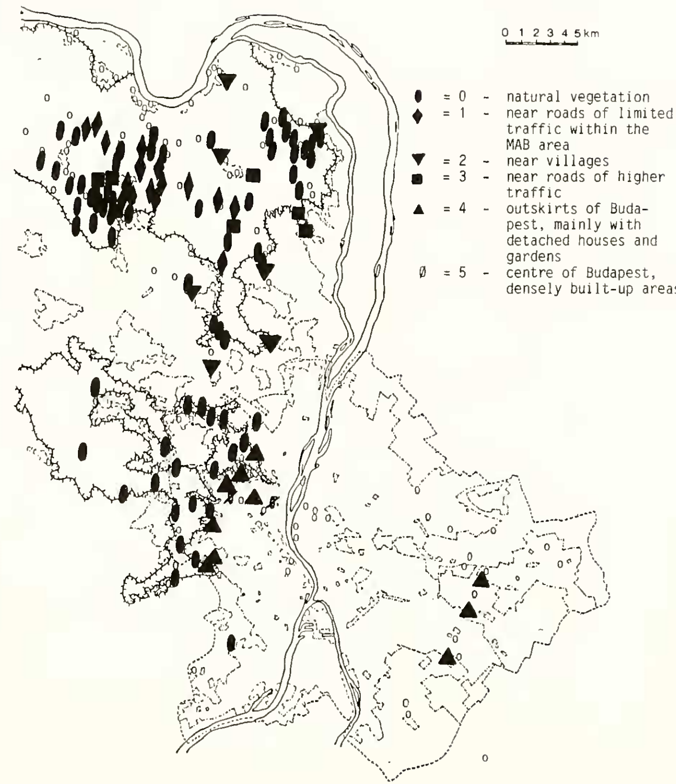


Fig. 3. (left) The correlation between the number of species and the number of locality types.
Fig. 4. (right) The distribution map of *Lecanora conizaeoides* in Budapest, in the Pilis and Visegrádi Mountains.

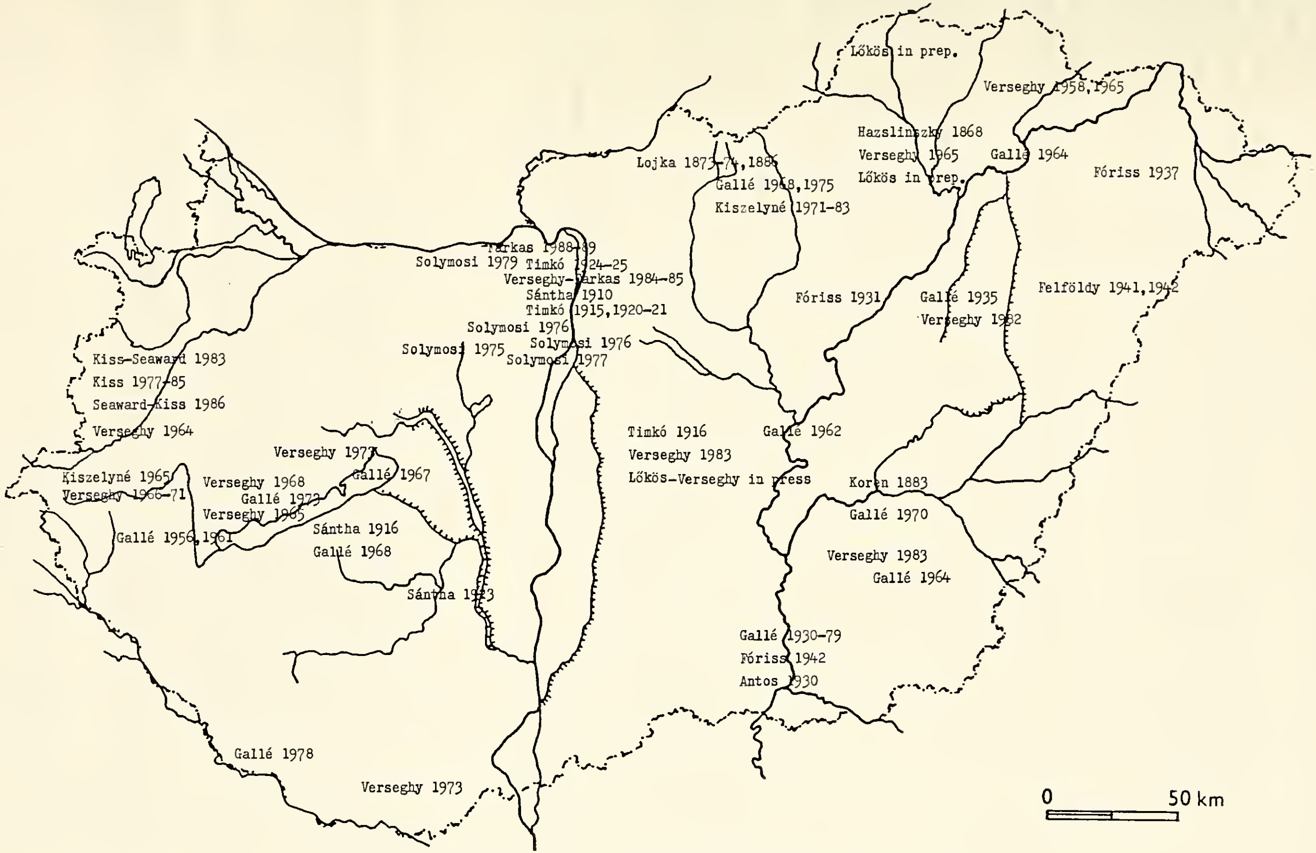


Fig. 5. Areas in Hungary studied in lichenological papers.

of the recent Hungarian lichen flora. Beyond these data, there are quite a few lichenological papers of the last c. 100 years on floristic data of smaller or larger areas of Hungary. They were published by the following authors: K. Antos, Á. Boros, F. Fóriss, L. Gallé, V. Gyelnik, F. Hazslinszky, T. Kiss, A. Kiszelyné, I. Koren, A. Pokorny, L. Sántha, P. Solymosi, Ö. Szatala, Gy. Timkó and K. Verseghy. The place here is not sufficient to present all of their publications, but references on Fig. 5 indicate the areas from which floristic papers have been published. In case of some papers (e. g. Gyelnik 1926, 1928; Szatala 1925–30) listing data from very different sites throughout the country, it was impossible to place them on the map.

Recently Verseghy (in press) has prepared the "Handbook of the Hungarian Lichen Flora" which contains also distribution data of the appr. 700 species including mainly the data of the Lichen Herbarium at BP.

Research of the Hungarian Natural History Museum (Budapest) has concentrated on the fauna and flora of the National Parks since 1972. Lichen floristic data of Hortobágy Nat. Park. were published by Verseghy (1982). Lökös and Verseghy just recently have prepared the manuscript on the lichen flora of Kiskunság N. P. using also the grid reference numbers of the system of the Central European Flora project (Niklfeld 1971). Similar papers are in preparation on the flora of Bükk N. P. and Aggtelek N. P. completed by the recent collections (Lökös in prep.).

There are different programs for mapping the Hungarian vascular flora (Borhidi 1984): The mapping grids of the Flora Europaea System using 52 basic squares of 50 km x 50 km and that of the Central European Flora project using 735 basic grids of about 10 km x 11 km. There is quite a good coincidence between the two grid systems (see Fig. 1 in Borhidi 1984).

The available data could enable us to begin with grid mapping of the Hungarian lichen flora. Since the increasing level of air pollution has a large influence on the lichens, the field work for mapping should be carried out before the sensitive species have entirely disappeared.

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Lichen Mapping in Austria

By Roman Türk, Salzburg

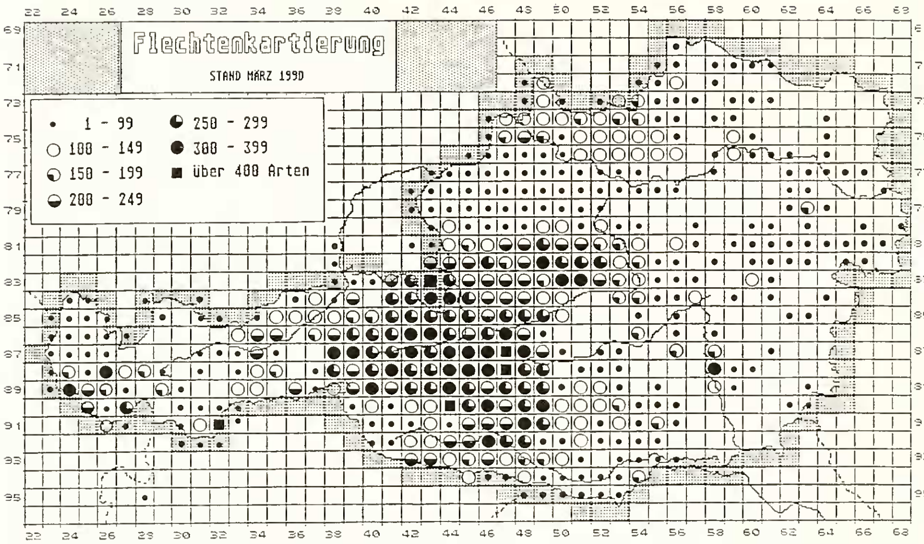
With 6 figures

Arnold's "Lichenologische Ausflüge in Tirol (1868–1897)" represent the first attempt to investigate the lichen flora and the phytogeographical differences in the distribution of lichens in the Alps. The results of his intensive floristic and taxonomic research were compiled by Dalla Torre & Sarnthein (1902) in "Die Flechten (Lichenes) von Tirol, Voralberg und Liechtenstein" and they are still an important basis for the study of lichen distribution and the changes of lichen flora caused by anthropogenic influences. In the 19th century Poetsch & Schiedermayr (1872) and Schiedermayr (1894) published a review on the lichen flora of the Austrian province Upper Austria and Sauter (1872) of the Salzburg province.

Although many lichenological collections have been made in the Austrian Alps during the last three decades, only a few surveys on the distribution of selected lichen species occurring in Austria or certain provinces have been published (e. g. Schauer 1965, Kalb 1970, Buschardt 1979). Since 1975 comprehensive mapping studies on lichens were started in Austria, following the appeal by Philippi & Wirth (1973). The grid system used for the floristic lichen mapping is described by Niklfeld (1971).

Until now the results have been published for two provinces: Upper Austria (Türk & Wittmann 1984) and Salzburg (Türk & Wittmann 1987). In Upper Austria especially macrolichens were studied with regard to air pollution and other human impacts (agriculture and forestry). A grant of the "Fonds zur Förderung der wissenschaftlichen Forschung (Project Nr. 5764)" enabled us to intensify our efforts in lichen mapping especially in the province of Salzburg, where we have so far registered more than 1300 species of lichens and lichenicolous fungi. Such a work cannot be carried out without support and assistance by lichenologists from other universities in Austria (Graz, Innsbruck) and other institutions (Vienna).

Substantial progress in lichen mapping in Austria has been made by the field meetings of the "Bryologisch-Lichenologische Arbeitsgemeinschaft für Mitteleuropa" in different provinces of Austria. All participants of these meetings placed the lists of lichens collected at the different localities at our disposal. The results of the excursions with a remarkable number of registered species were published by Heiselmayer & Türk (1979; Salzburg, Flachgau), Poelt & Türk (1984; Salzburg, Lungau) and Mayrhofer et al. (1989; Vorarlberg). The publication of the last field meeting in Eastern Tyrol is in preparation (Hoffmann & Gärtner). Further details on floristic work in Austria are given by Hawksworth & Ahti (1990). At present about 65.000 records for 1.800 taxa of lichens and lichenicolous fungi have been registered. We expect that the number of lichen species will rise to 2.000 or more after our investigations on the lichen flora of the climatically more favourable regions of Austria, especially of the lowlands of Lower Austria and Burgenland.



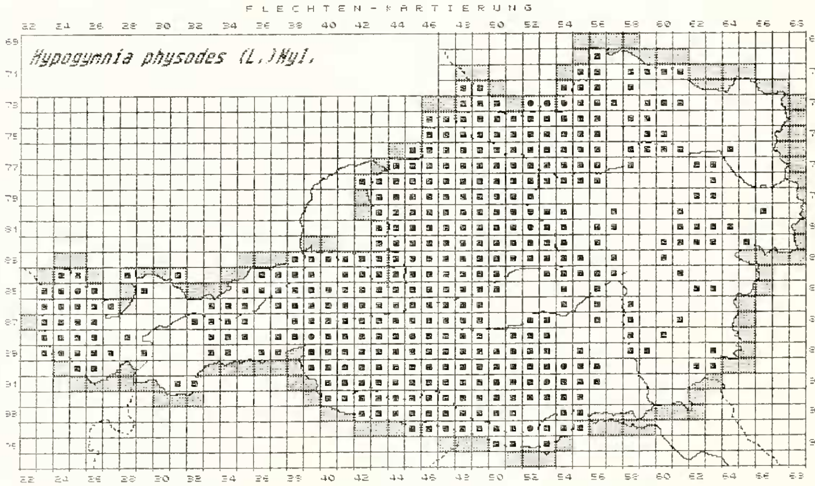
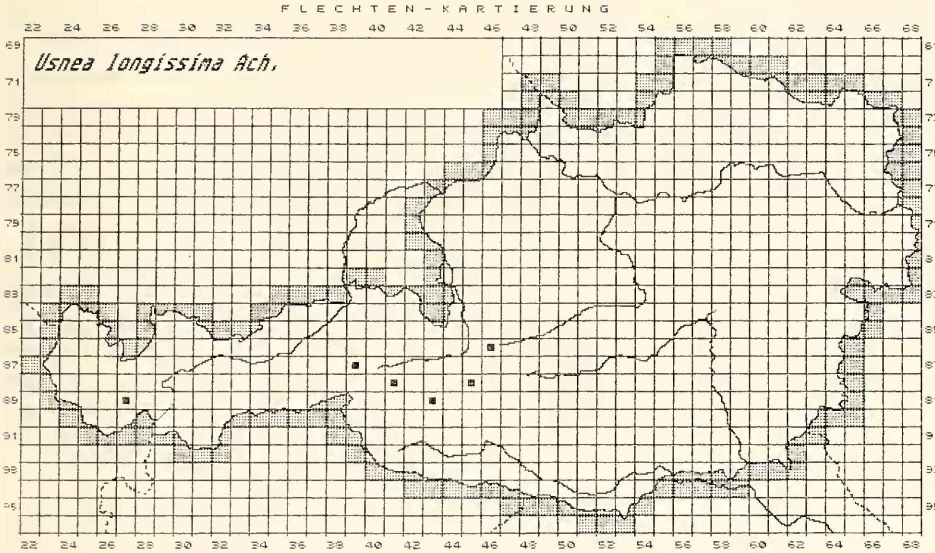
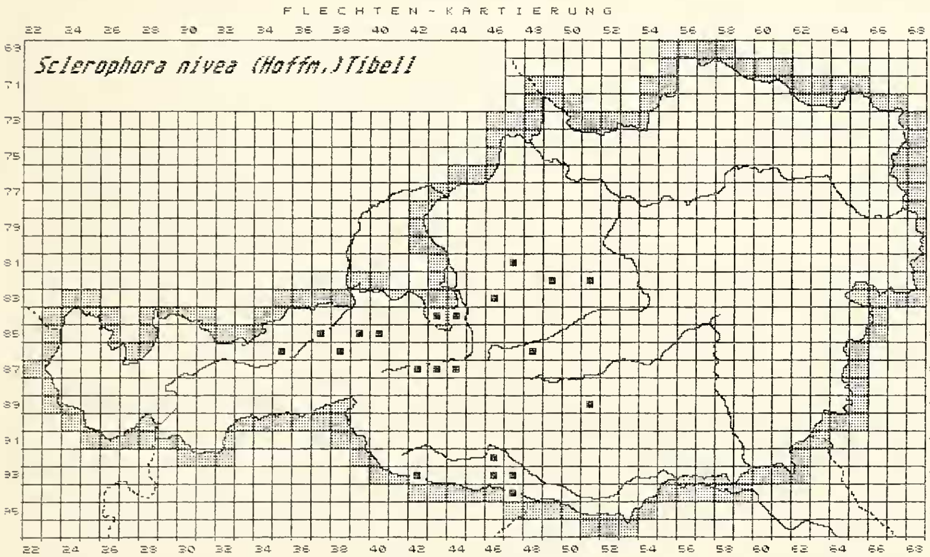


Fig. 1. (above) Grid-map of Austria with the numbers of recorded lichen species per mapping unit.

Fig. 2. *Hypogymnia physodes* (L.) Nyl.; actual distribution.





Figs. 3–4. Actual distribution of 2 lichen species. – 3. *Usnea longissima* Ach.; – 4. *Sclerophora nivea* (Hoffm.) Tibell.

Since 1989 data are stored on computer files. A special programme (HARTL & RADIC 1989; „BIODAT") enables us to store the large database and to print the distribution maps of any registered species occurring in Austria as well as in the separate provinces. The distribution maps show the distribution of lichens recorded since 1975. The integration of pre–1975 data from lichen herbaria and literature is planned for the next three jears. In addition to a bibliographical survey, our goal is to demonstrate the change of the lichen flora in Austria during the last hundred years.

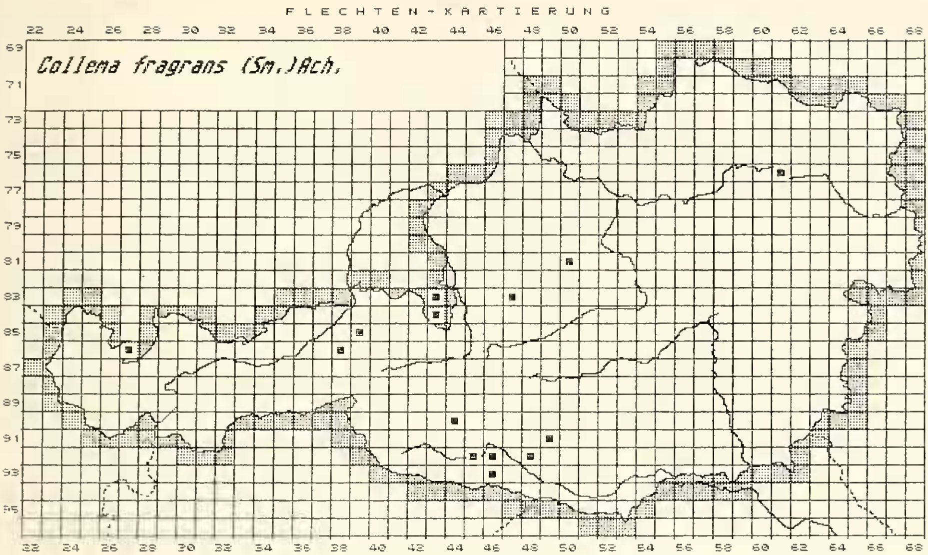
The total area of Austria is 83.849 km² and it covers 702 recording units of the mapping grids of Central Europe (10' longitude, 6' latitude). 65% of the total area is mountainous with altitudes of more than 1.000 meters. The varied topography at the edges of the Alps and within the Alps implies a high climatic and geological diversity. Precipitation rates vary from 500 to 2.800 mm per year. Due to the geological and climatical diversity lichens with extreme ecological demands can occur. The lichen flora includes oceanic and continental species as well as acidophilous and basiphilous species.

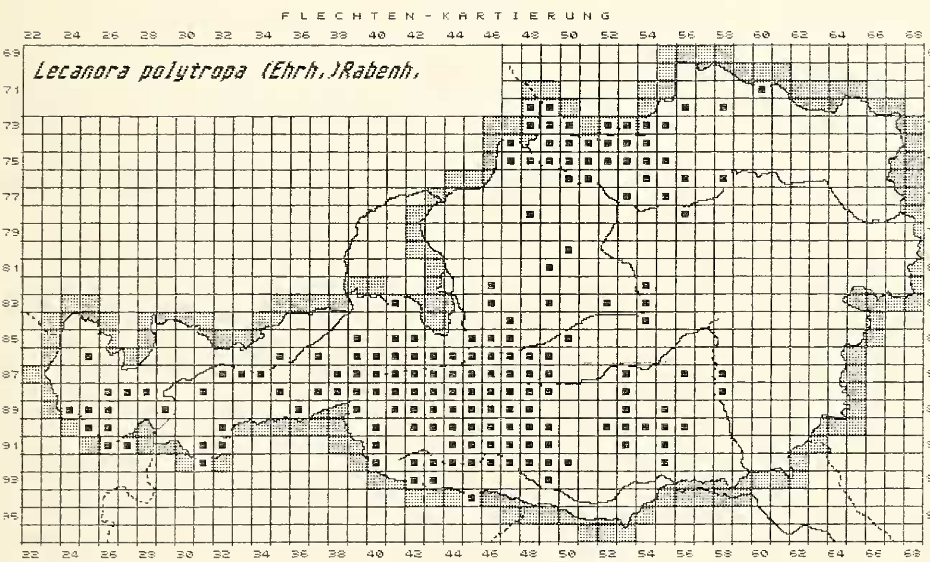
The total number of lichen species of the different grid squares is shown in Fig. 1. Whereas the number of lichen species recorded per grid square is relatively low in the Prealps (between 50 to 100 species), it rises significantly in the northern margins of the Alps and increases to more than 500 species in the Central Alps. The distribution map of the widely distributed lichen *Hypogymnia physodes* (Fig. 2) shows where mapping studies have been carried out and where information is lacking. The species number per grid square not only shows the degree of human impact on the terrestrial ecosystems but also serves as a criterion for the evaluation of landscape quality. The more microhabitats suitable for lichen colonization are preserved in a region the higher is the species diversity in the investigated area. Thus Fig. 1 illustrates the intensity of the land use and vice-versa the natural environmental quality of a region.

At the northern border of the Alps many sensitive lichen species show visible damage caused by far range immissions of SO_2 up to an elevation of 1.400 to 1.700 m. This SO_2-pollution took place mainly in the winter 1984/85 and 1985/86 and injured primarily the large lobed lichens *Lobaria pulmonaria*, *Cetrelia cetrarioides*, *Parmelia* spp., *Peltigera* spp., and fruticose species. In some regions the entire macrolichen flora was damaged so severely, that in some cases the extinction must be assumed (WITTMANN & TÜRK 1988). During the last three winter periods this type of far range pollution did not appear and those lichens which were not lethally damaged showed a significant degree of recovery. After a period of one to one and a half years lobulae grew out from damaged lobes and showed a healthy development.

The preliminary results of the mapping studies are presented in the following distribution maps for some selected species in Austria. A very rare lichen is *Usnea longissima* (Fig. 3) which was formerly much more frequent than now. This species is highly affected by modern forest practices and air pollution by gaseous pollutants and acid rain.

Sclerophora nivea (Fig. 4), a tiny crustose lichen with stalked, white apothecia grows on the bark of old trees (mainly *Acer pseudoplatanus*, *Fraxinus excelsior* and *Ulmus* spec.) in stem flow furrows. The bark must have a high water retention capacity. Thus *Sclerophora nivea* settles on old trees with softened bark and in regions with high relative humidity. The combination of all these factors is relatively rare as shown in Fig. 4. This lichen is widely distributed in the Austrian Alps.





Figs. 5–6. Actual distribution of 2 lichen species. – 5. *Collema fragrans* (Sm.) Ach.; – 6. *Lecanora polytropa* (Ehrh.) Rabenh.

A further example for a rare resp. easily overlooked lichen, is *Collema fragrans* (Fig. 5) with similar ecological demands as *Sclerophora nivea*. This lichen is mainly distributed in the montane zone of the Alps. Outside the Alps *Collema fragrans* occurs in the Danube valley on old ash trees in floodplain forests.

Lecanora polytropa is a common saxicolous lichen on acidic to slightly acidic rocks from the lowlands up to the alpine zone. Its natural distribution is on granitic rocks of the Bohemian Mass (northern region) and on shale, Gneis and sandstones in the

Alps (Fig. 6). In the Prealps *Lecanora polytropa* can occasionally be found on granitic tombstones and on old tiles.

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The author is very much indebted to all colleagues and collectors of lichens who assisted in the determination of difficult species and placed lichen records at our disposal as well as to Dr. W. RUETZ (Teisendorf, FRG) for critical remarks on the manuscript.

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Lichen Mapping in Switzerland: The Epiphytic Lichens of the Plateau and the Prealps

By Philippe Clerc, Bern and Christoph Scheidegger, Birmensdorf

With 1 figure

Summary

A lichen mapping project has been started in Switzerland. The aims of the project are to provide chorological information as well as data for nature conservation. In a first stage this project will focus on the epiphytic lichens of the Central Plateau and the northern Prealps. This area has been divided into 187 mapping units of 10 km x 10 km according to the national grid of Switzerland. Quantitative as well as qualitative aspects will be studied. In each mapping unit a minimum program will be carried out, ensuring standardization. As far as they are available, historical data will be taken into account. The data will be stored in a relational database ("Biodat") on PC computers.

1. Introduction

Since the death of Eduard Frey in 1974 (Welten & Ammann 1976) lichen floristics in Switzerland went through a silent but fruitful period of reorganisation. Today, about 15 trained lichenologists are willing to contribute to a lichen mapping project.

However, it would be a serious mistake to underestimate such a task as mapping the lichen flora in a country like Switzerland. When planning such a project one has to keep in mind at least three important facts:

Firstly, lichenology is far from being strongly and definitively established in the country. Unlike the mapping project for vascular plants (Welten & Sutter 1982) and bryophytes (Urmi et al. 1990), our project will be done, at least in its first stage, in spare time. Moreover the number of amateur lichenologists is very small (about one tenth of the number participating in the lichen mapping project of the British Isles (Seaward & Hitch 1982)).

Secondly although being one of the smallest countries in Europe (41.288 km^2), Switzerland shows an extreme diversity of the lichen flora:

Its altitudinal range extends from 193 to 4634 m. a.s.l., covering all the zones between the colline and nival belts with a well developed arctic-alpine element at the highest altitudes (Frey 1960).

Because of its central geographic position in Europe, Switzerland is a meeting point of several important phytogeographical elements, e. g., the oceanic west European element and the mediterranean element.

There are several specific and interesting habitats, e. g., the inner alpine dry valleys (Buschardt 1979) or the insubrian area in the southern Alps (warm oceanic element).

The high complexity of the alpine geology covers the whole range of rock types except for most of the volcanic substrates.

Thirdly many alpine rock habitats are not easily accessible, so that time and energy needed for mapping their flora is greater.

Considering these points it is not surprising that Switzerland is one of the last European countries to initiate a national lichen mapping project.

2. Background

Beside providing strictly chorological information (atlas with distribution maps of the lichen species of the area studied) the project aims at emphasizing aspects of nature conservation. Lichens are very sensitive indicators of air pollution (Ferry et al. 1973, Hawksworth & Rose 1976, Jürging 1975) and site disturbance (Rose 1976, Groner & Clerc 1988, Wildi & Camenzind 1990, Dussex & Held 1990). There are indications of rapid changes in the lichen flora of industrial countries. A main goal of this project is to characterize rare and endangered species ("Red data lists"), outline rare biotops or habitats of special interest, and protect these biotopes and their flora.

Epiphytic lichens are among the most threatened organisms in Europe and the epiphytic flora has undergone dramatic changes (Wirth 1976, Türk & Wittmann 1986, Wirth 1987, Ruoss & Clerc 1987). There is little information about their distribution in Switzerland. Easily recognizable macrolichens are an important part of this group and the percentage of taxonomically well defined taxa is much higher for epiphytic than for, e. g. saxicolous lichens.

These last two points are important if we consider the accuracy of field work and determinations as well as the training of collaborators.

The Swiss Central Plateau, with its high population density, its very dense network of roads, its industry, and its intensive farming is the area of strongest conflicts between man and nature. Consequently it is on the Plateau and adjacent areas where lichens are threatened most and here the most obvious regression of the lichen flora has been observed. Furthermore the Plateau is the area best accessible in Switzerland, this being important when considering time invested in travelling.

The Northern Prealps shelter many rare epiphytic communities, e. g. the oceanic west european element in central Switzerland (Clerc 1984, Groner & Clerc 1988, Groner 1990, Dietrich 1990, Wildi & Camenzind 1990) with small ecological amplitude, very sensitive to site disturbance like intensive forest management (Esseen et al. 1981), air pollution and wet acidic deposition (Farmer et al. 1990). Moreover this area is of high interest within the frame of forest decline studies.

Such a project should not last more than five years from the start to the publication of the results in order to avoid outdating of the first observations at the time of publication as well as to maintain interest and enthusiasm among mostly honorary collaborators.

3. The project

The points considered above recommend an initial project limited in time and size, focusing on the most threatened organisms and most sensitive areas. For this reason we decided to map the epiphytic lichens of the Swiss Central Plateau and the northern Prealps first. However, the project will be organized and managed in such a way that it will be a good basis for a future mapping of all lichens in Switzerland. This means that data collected from other substrates and areas, e. g., saxicolous species from the alpine zone, can readily be incorporated in the data bank.

Interpretation of the data at the regional or national level requires a more detailed grid than the one used at the European level. For this reason we decided to choose square mapping units of 10 km x 10 km according to the national grid of Switzer-

land. The data can then be transferred to the 50 km x 50 km UTM grid to be used for the European mapping project by a computer program.

Field work in the 187 square units (Fig. 1) will rely partly (relevés A and B) on the methods developed and used within the framework of the Natural Inventory of the Swiss Bryophytes (URMI et al. 1990). A so called minimum program will be carried out for each 10 km x 10 km square. This will ensure standardization of the investigation of the units: Each mapping unit will be investigated with the same intensity and selectivity, resulting in an equal density of collection over the whole area. The following types of standard-relevés are planned:

Relevés A: For each square unit, several localities will be studied whose coordinates have been randomly established. These relevés will provide important quantitative information on the flora, often neglected in such projects. We will be able to determine statistically the frequency of any given species in a relevé A with respect to other species.

Relevés B: For each square unit, localities will be selected by the field-worker himself, on the basis of his field-knowledge and experience. Each relevé of type B will have to be of a different habitat type: forest, isolated trees, orchard trees etc. Focusing on the qualitative side of the information collected, this type of relevé is complementary to the former one, covering rare habitats seldom or never recorded by the type A relevés. Particular attention will be paid to localities with a rich or unique epiphytic lichen flora.

The size of the relevés of type A and B, as well as their respective number for each 10 km x 10 km square is still a matter of discussion.

Relevés H: From 1920 to 1974, EDUARD FREY, the most important contributor to lichen floristics in Switzerland in this century, visited numerous localities in the mapping area. Besides collecting specimens (deposited in the herbarium BERN) he made notes on all species he observed and often made relevés. His notebooks are very precious documents of the past situation of the lichen flora of these localities. They will be analysed and as far as the collecting sites can be precisely localised in the field, new relevés will be made on the same tree if possible. Historical notes and collections of other lichenologist will also be taken into consideration. This will give a fairly accurate idea about the floristic changes since the first relevés.

In addition to these standardized relevés traditional field work will be done in many mapping units, allowing to record rarer species. These records will be kept and processed apart in order to differentiate them, on the maps, from data collected in standard relevés.

For selected species herbarium specimens of every large public herbarium in Switzerland (BERN, G, LAUS, Z, ZT) and abroad (e. g. STR) will be analysed and mapped.

All the data collected will be electronically processed and stored in a relational data bank. The program (BIODAT) was written by PAUL DIEDERICH (Luxembourg) and will be adapted for this project. This ensures full compatibility with mapping projects of other European countries using the same program (Belgium, Luxembourg).

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We wish to thank Dr. P. DIEDERICH (Luxembourg) for supplying the program „BIODAT“ and for his assistance and advices concerning the latter. We are most grateful to the following colleagues for their comments on this text: Dr. K. AMMANN (Bern); M. DIETRICH (Bern); Dr.

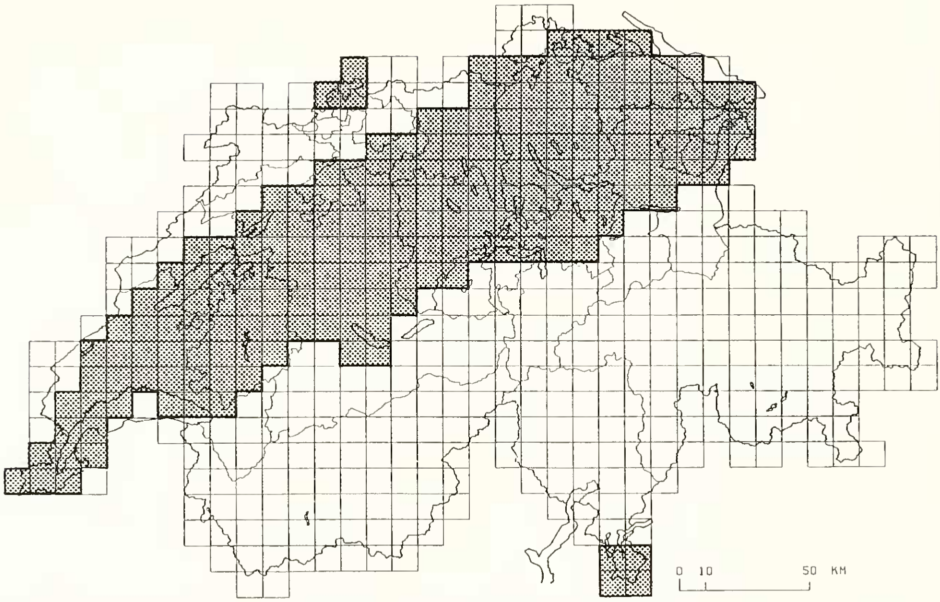

Fig. 1. National grid of Switzerland with mapping units of 10 km x 10 km. – *Dotted area*: area to be mapped in the first stage.

U. GRONER (Zürich); C. KELLER and E. WILDI (Bern). Special thanks are due to Dr. E. URMI and Dr. N. SCHNYDER (Zürich) for supplying the map with the 10 km x 10 km grid system as well as for introducing us to the „Oracle" database. We would also like to thank M. SIEBER (Birmensdorf) for linguistic corrections of the manuscript.

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Lichen Mapping in the German Democratic Republic – Principles and Examples

By Ludwig Meinunger, Steinach and Peter Scholz, Markkleeberg

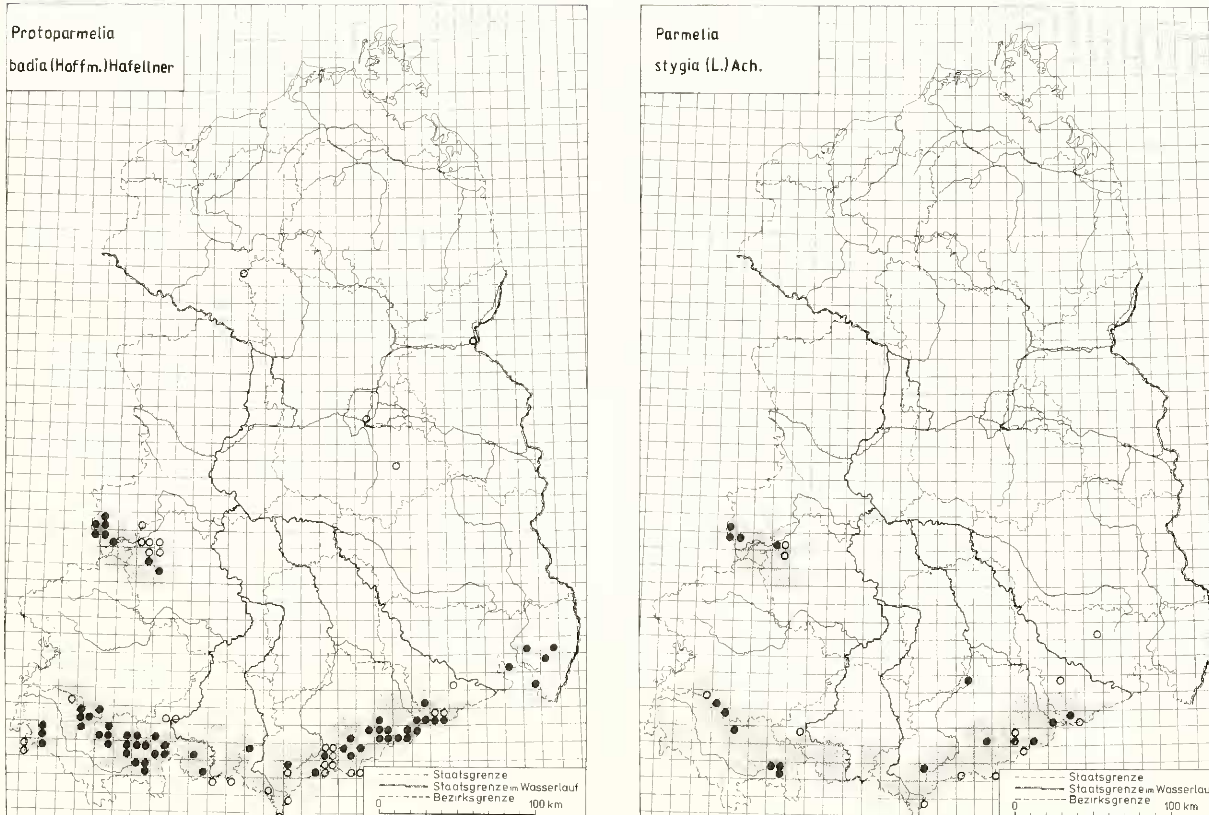
With 6 figures

The publications of Grummann (1963) and Scholz (1986) offer an almost complete bibliography of lichenological papers dealing with the territory of the GDR. An assessment of the older literature is rather difficult yet, due to changes in taxonomy and partly also because of obviously unreliable data given there.

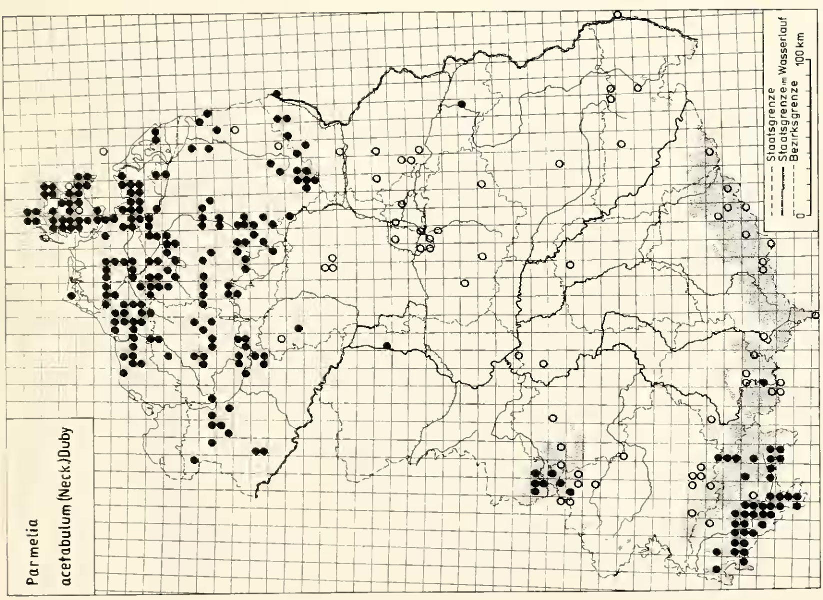
In the first half of our century prominent lichenologists had been working in our area. Among them were Hillmann, Schultz-Korth and Grummann in the region of Brandenburg and on the Isle of Rügen, Lettau in Thuringia and Schade in Saxony whose papers cope even with modern standards. In 1955 Schade, the last representative of this generation, wrote with resignation (Schade 1955: 196):

> „Wenn es jemand für überflüssig halten sollte, daß . . . alle mir bekannt gewordenen Fundorte mit den Einzelheiten angegeben werden, so darf man demgegenüber nach der eigenen Erfahrung gewiß sein, daß spätere Lichenologen dankbar daraus Nutzen ziehen werden, zumal nach dem Tode unserer alten Generation alle mündliche Tradition in unserem Lande abreißt, da kein junger Nachwuchs vorhanden ist.“ (“If anybody regards it to be superfluous . . . to communicate all localities known to me in detail, then it may be stated by experience with certainty, that future lichenologists will gratefully profit of it, the more so because any oral tradition will cease in this country after the death of our old generation as a junior generation is missing.”)

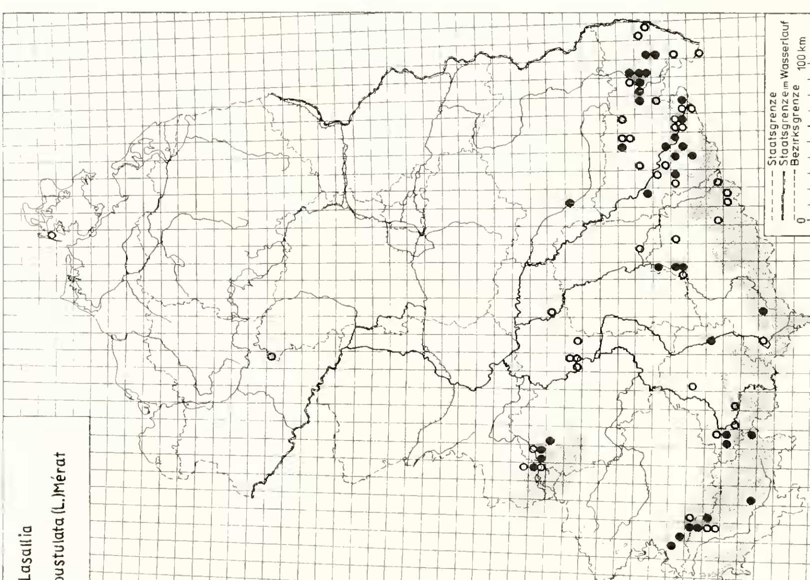
During the decades following the end of World War II lichenological activities and knowledge had been low compared to the ones of the authorities mentioned above. There are, however, noteworthy papers by Doll (1982) on the Mecklenburg region, Schubert & Klement (1961) on the upper Harz Mountains, Büttner (1959) on Saxony and Marstaller on Thuringia. Only in the last decade the interest in lichenology has increased again. An essential prerequisite was the publication of modern literature with keys for the identification of lichens, especially the flora by Wirth (1980). Moreover, the great importance of lichens as sensitive bioindicators in nature and environment protection had become generally recognized. Lignite is mined and burnt in great quantities in huge areas of the central and southern parts of the GDR. Resulting environmental changes and high levels of air pollution have caused a disastrous decline of the lichen flora. Even formerly common species have disappeared in large areas. Nevertheless new records have been made. The recently described species *Mycoblastus sterilis* and *Fuscidea viridis* have been recorded for the first time for the GDR. *Micarea botryoides* was recently recorded from the Thüringer Wald (Thuringian Forest), the Harz Mountains, the Erzgebirge (Ore Mountains) and from Oberlausitz, where it seems to be widely distributed. Since about 1980 a card-file of lichen records which primarily serves for a registration of the actual flora was compiled by the senior author (L. M.). Data are being contributed by about 30 co-workers. Lichenological works have been completed or are in progress at some universities. Examination of most older herbaria had to be postponed because of lack of time.

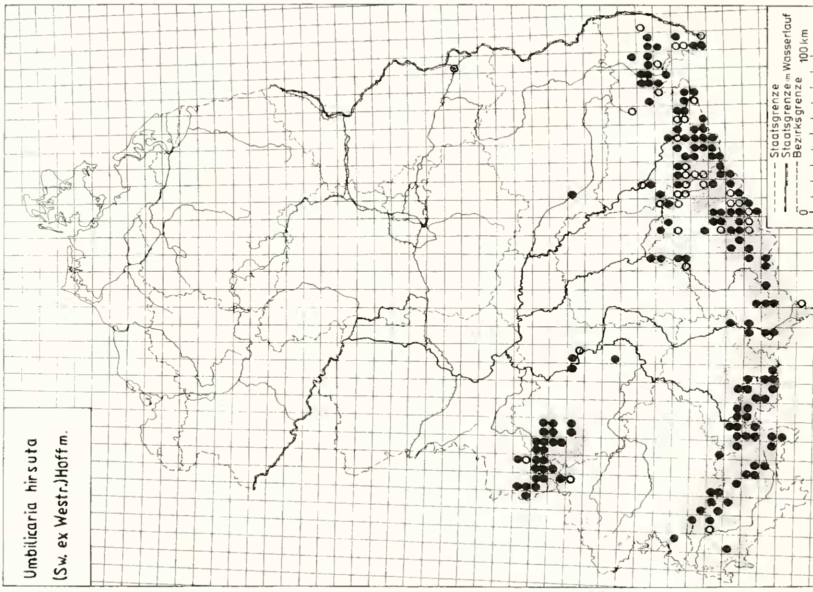


Figs. 1–2. Distribution of 2 lichen species in the GDR. – 1. *Protoparmelia badia*; – 2. *Parmelia stygia*. – In all figures: *circles* = pre 1975, *dots* = 1975 onward.



Figs. 3–4. Distribution of 2 lichen species in the GDR. – 3. *Parmelia acetabulum*; – 4. *Anaptychia ciliaris*.





Figs. 5–6. Distribtuion of 2 lichen species in the GDR. – 5. *Lasallia pustulata*; – 6. *Umbilicaria hirsuta*.

A first series of distribution maps for the lichen families Baeomycetaceae and Umbilicariaceae was worked out by the junior author (SCHOLZ in press). They include all data available from herbaria and literature. This series of distribution maps is planned to be continued in the next years on, e. g. the genera *Cetraria, Peltigera* and *Xanthoria*.

Mapping is based on quadrant-grids of the topographical map 1 : 25.000 (so called "Meßtischblatt"), which is being used in most Central European countries and in the mapping projects of vascular plants, bryophytes and fungi of the GDR, too. Distribution maps of six easily identifiable species are presented as examples (Fig. 1–6). Records from 1975 and later are indicated by black dots, older ones by open circles. Dotted open circles refer to localities which may lie slightly beyond the limits of the respective grid unit.

Protoparmelia badia (Fig. 1) is an inhabitant of open siliceous rocks mostly in the montane region and it is regularly found in suitable localities in the Harz, the Rhön, the Thüringer Wald and the Erzgebirge, more rarely in the mountain region of the Oberlausitz. This species seems to be threatened in a minor degree at present. There are no recent records from lowland localities, which are sometimes mentioned in older literature.

Parmelia stygia (Fig. 2) is a strictly montane species, scattered on rocks and rockslides in mountain regions. It has been recorded also from a few extraordinary localities at lower altitudes. There are no records from secondary habitats. This species has survived at most known localities, of which some are integrated into nature reserves. It is little endangered. Recently lime-powder was scattered over forest areas by planes in order to fight symptoms of "waldsterben". The effects of this treatment on the siliceous rock lichen flora must carefully be observed.

Parmelia acetabulum (Fig. 3) has been distributed throughout the whole area according to older literature. Its recent distribution typically represents the actual situation of epiphytes. The best localities for epiphytes lie in the northern part of the GDR, especially on the coastline of the Baltic Sea. They decline in number towards south to Brandenburg and the Berlin region. A few localities have been recorded in the humid parts of the Harz and the Thüringer Wald but there exist no recent records from the more dry, warm and densely industrialized areas east of the Harz, from the Thuringian Basin and Saxony. It seems to be extinct there. The present situation in the flora of epiphytes is only better in the extreme south-western part, especially in the Muschelkalk region south of the Thüringer Wald. The occurence of *P. acetabulum* there agrees well with its distribution pattern in north-western Bavaria (RITSCHEL 1977: 67).

What has been said about *P. acetabulum* is valid for *Anaptychia ciliaris* (Fig. 4), too. Formerly it was also distributed in the whole area but less common. Present records are very scattered in the northern part and in southern Thuringia, restricted there to the valley of the Werra.

Lasallia pustulata (Fig. 5) is distributed from lowland up to the lower mountain level, generally below 500 m. The highest altitude was recorded at a locality at 720 m in the Vogtland region. Suitable substrata, siliceous rock at localities with favourable temperature conditions, are rare in lowland areas and can only be found in the mountains or in lower mountains like in Sächsische Schweiz with its sandstone rocks or in the Oberlausitz with granite rocks at low altitudes. The re-examination of known localities confirmed its presence in many cases. At some localities, e. g. in the

Harz, it was found to be abundant and associated with other characteristic species, forming a Lasallietum pustulatae there. Yet, *L. pustulata* seems to have disappeared at the porphyrite rock localities near Halle, probably due to severe pollution in this industrial area.

Umbilicaria hirsuta (Fig. 6) is the most common species among the Umbilicariaceae in our area. It occurs in the Umbilicarietum hirsutae, associated by *Umbilicaria polyphylla* and other species. It is very often found on siliceous rock from lower altitudes up to the upper mountain level. There are no records from the northern part of the GDR.

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Lichen Mapping in the German Democratic Republic – State and Problems

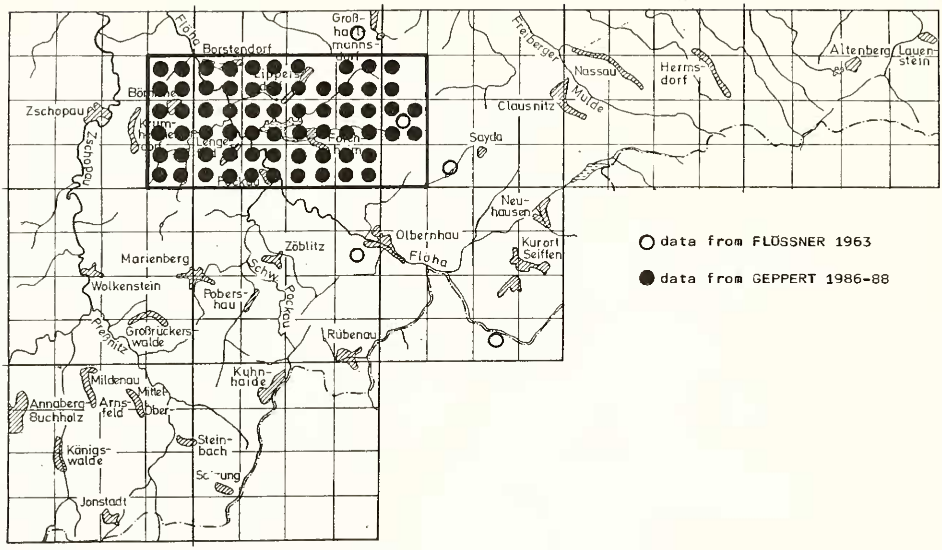
By Regine Stordeur, Halle

With 3 figures

Lichen mapping in the GDR is not very advanced, because it is not possible to refer to a continuous work ranging over decades like in higher plants. After the death of distinguished lichenologists as Hillmann, Schultz-Korth, Schade and others (see contribution of Meinunger & Scholz, this vol.) there were few activities in this field of research after World War II. From the older generation Flössner must be mentioned in the first place (additional names are given by Meinunger & Scholz, this vol.), who collected lichens in the central and eastern parts of the Erzgebirge (Ore Mountains) for c. 20 years. His results were published in 1963.

Since about 1980, mainly younger persons began to study lichenological problems again. Although at that time several valuable keys for lichen identification already existed (e. g. Poelt 1969, Poelt & Vězda 1977, Wirth 1980), initial problems were severe because there was no guidance by experienced teachers. Exchange of experience or literature with colleagues in foreign countries developed only slowly. At present c. 30 persons cooperate in the registration of lichens in the GDR. Mapping of lichens is carried out in accordance to that of higher plants. Both are based on topographical maps [1 : 25.000, so called "Meßtischblatt" (MTB)], published from c. 1900 to 1935, which are being subdivided into 4 quadrants (see figures in Meinunger & Scholz, this vol.). This grid system allows comparison with results of the mapping of higher plants and, on the other hand, guarantees compatibility with the systems of neighbouring countries. The modern topographical maps, developed a few years ago, do not correspond to those of neighbouring countries as they are based on a different grid system. Furthermore, geological informations are only available for the earlier maps.

At present data storage is still performed manually on card files both for literature data and for actual field records. For every species the following data are registrated: location (four digit number of MTB), authority or observer, date of record resp. year of publication, a short note on possibly existing herbarium specimens, and the substrate. Whereas recent locations can immediately be noted, a localization of old herbarium material and of literature data covering the whole country is yet impossible at the moment. At present this work is under progress in a few regions in the course of student's examination works, e. g. on the Isle of Rügen, the Harz Mountains, the Erzgebirge. The results allow statements on a decline of several species or their tendency to spread. For such special topics grids of lower scale are used in some cases, too. Fig. 1 and 2 (Geppert 1989) show two examples which resulted from a more detailed mapping of the central part of the Erzgebirge with 64 units per MTB. A comparison of historical data obtained from literature (empty circles: records before 1963) with recent data (filled circles: records from 1986–1988) shows a distinct expansion of the area of *Lecanora conizaeoides* (Fig. 1) caused by an increase in air pollution, especially by SO_2. The enhancement of *Lecanora dispersa* (Fig. 2) results



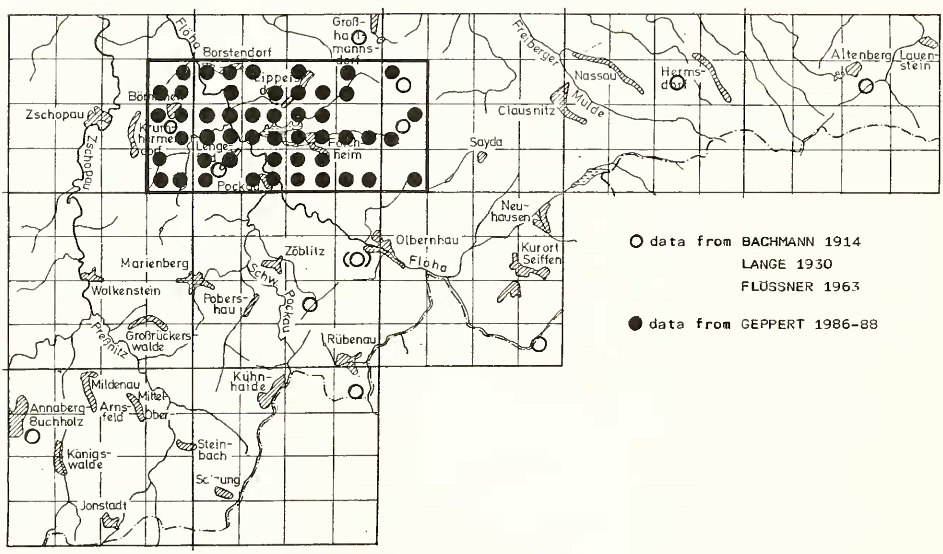


Fig. 1. (above) Expansion of the area of *Lecanora conizaeoides* in the central part of the Erzgebirge (after GEPPERT 1989).

Fig. 2. (below) Old and new records of *Lecanora dispersa* occurring on man-made substrate (after GEPPERT 1989).

from a growing use of manufactured concrete elements for fences, roadside posts etc. in forest areas where naturally acid siliceous rock dominates.

The methods of data management mentioned above will be used until free computer capacity and technical staff will be available after the completion of the Distribution Atlas of the Higher Plants of the GDR in 1990 or 1992. There already exist programs for databases, which allow to list all localities of a certain species as well as all recorded species of a certain locality. They also permit to process data and to print distribution maps.

We agree with the application of the UTM-grid system, proposed for the European lichen mapping project. It will reveal differences in the areas of Central European species with a sufficient degree of exactness and it allows comparison with distribution maps of higher plants. The territory of the GDR would be covered by c. 60 grid units of 50 km to 50 km. Considering that more than 40% of these grid units are not investigated at all at the moment, a total of 50–60% of the territory must be stated to be underinvestigated. At present research progress is limited by field work capacity. Most of the 30 co-workers mentioned above are non-professionals. Both professionals and non-professionals can spend only limited time on lichenological work. Only a part of the collaborators are capable to identify common species with certainty or under field conditions without assistance. All others confine their activities to the registration of easy identifiable species, collecting material only sporadically or send their material to the few experts in the GDR, who themselves have to consult foreign specialists for identification of critical specimens. Yet, this work is appreciated, because it contributes to a compilation of localities of several species. A disadvantage of this procedure is the possible decimation of rare or even threatened species.

In order to cope with the problems of research capacity mentioned above, several diploma or doctoral theses on lichenological investigations of certain areas have been initiated. In this way the number of persons who are able to identify species, to map lichens and to assist beginners shall rise. At Rostock University an active group (Giersberg, Dieminger) is working on lichen distribution around a fertilizer plant and on other ecological problems, on lichen mapping at the coastline and in parts of the Mecklenburg region as well as on phytosociological problems. At Halle University several lichenological projects have been carried out in the past, mainly on bioindicative problems (Bartholome, Heins, Wettig, Schubert). At present floristical and phytosociological investigations of certain areas dominate (Litterski: Isle of Rügen; Geppert: parts of the Erzgebirge; Scholz: Harz Mountains; Stordeur: Halle area). At Jena resp. Dresden University and at Halle Teacher Training College lichenological examination papers have been worked out, too.

Furthermore, professional training courses are held for all persons interested in lichenology during annual workshops. These workshops include excursions, identification courses and presentation of critical species and results. Numerous collaborators, working on floristics of higher plants, mosses or fungi or on problems of nature conservation until then, joined the lichen mapping after these courses. Fig. 3 shows areas of the GDR covered by lichenological investigations, but from numerous of these areas only sporadical collections or phytosociological data exist. Centres of research acitivities lie in the northern and in the southern parts of the GDR. At the moment some areas like Thuringia (Meinunger and collaborators) and the Harz Mountains (Scholz, more than 300 species recorded until now) are quite well in-

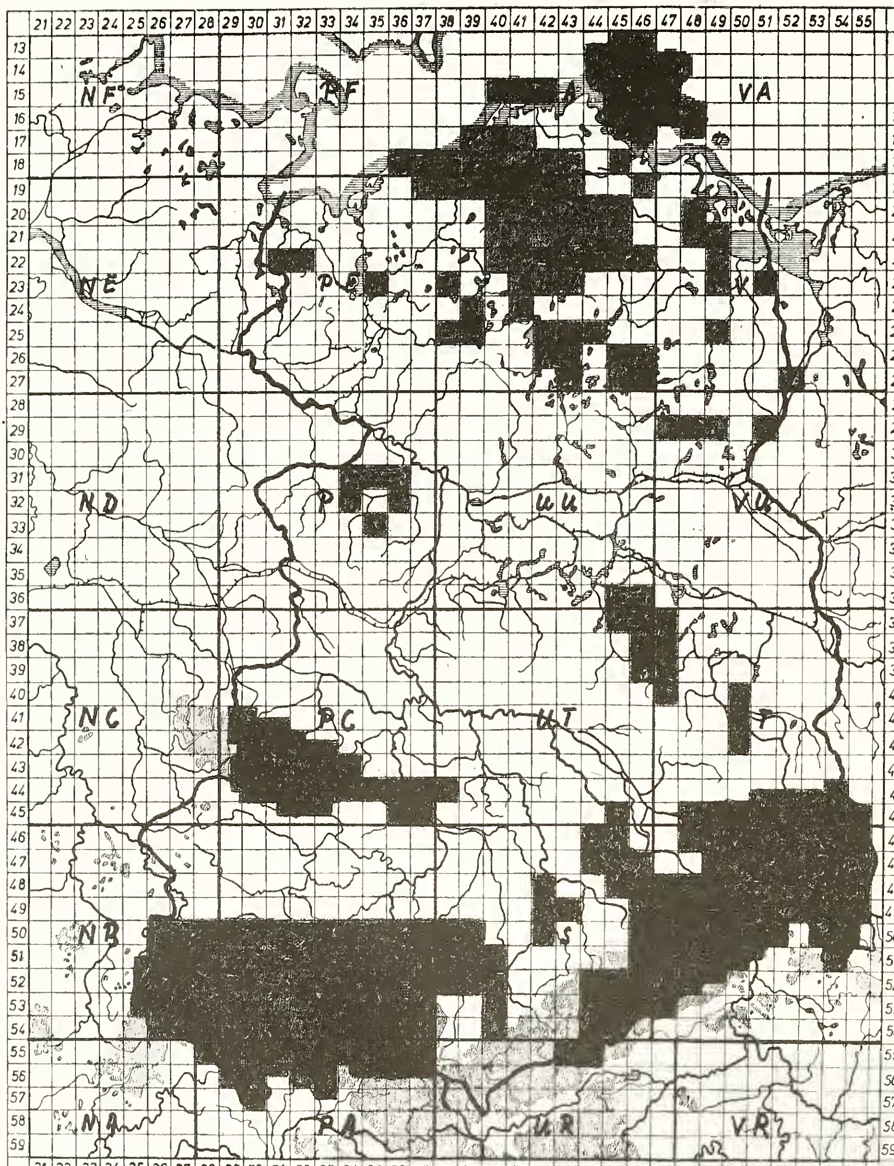


Fig. 3. Areas of the German Democratic Republic from which floristical and phytosociological data are available at present. – *Collaborators:* Doll, R.; Dieminger, J.; Foitzik, O.; Funk, B.; Geithner, A.; Geppert, H.; Giersberg, M.; Gnüchtel, A.; Hennig, S.; Jeremies, M.; Litterski, B.; Meinunger, L.; Müller, F.; Ober, A.; Rettig, J.; Rommer, P.; Scholz, P.; Schulz, U.; Schwarz, R.; Schwarz, U.; Stordeur, R.; Wolf, A.

vestigated. From the Oberlausitz, a landscape in the south-eastern part of the GDR, 150 species are recorded in a card index (JEREMIES). From parts of the Erzgebirge, of Saxony and of the Sächsische Schweiz (GEPPERT, GNÜCHTEL) a number of c. 100–150 species has been recorded. In spite of the severe decline in lichen vegetation, a higher species number must be expected. Also from the northern parts of the GDR (coast and parts of Mecklenburg) plenty of data exist, e. g. from the Isle of Rügen, where c. 320 species have been recorded (LITTERSKI).

Although MEINUNGER and SCHOLZ are able to present the first maps for the GDR (see this vol.), the whole central part of the territory must be regarded as incompletely or poorly investigated (Fig. 3). Therefore the future annual workshops and training courses of the cryptogam group of Halle University will predominantly be held in poorly investigated areas in order to promote the progresss of lichen mapping. Field lists as used for mapping higher plants in GDR and in other countries also for mosses and lichens, are not considered because of the still rather poor knowlegde of many of the collaborators on species identification. They easily tempt to underline species not identified with certainty. To avoid this mistake is of special importance in the case of species which are decreasing strongly.

An increasing degree of air pollution, an intensification in agriculture and forestry, expanding road-construction etc. have led to a drastic decrease mainly of epiphytic species in the last decades (see maps of *Parmelia acetabulum* and *Anaptychia ciliaris* in MEINUNGER & SCHOLZ, this vol.). Therefore an immediate documentation is urgently required. It is advisable, to start the European lichen mapping project with such sensitive species resp. genera as *Usnea*, *Alectoria*, *Ramalina*, *Parmelia*, *Calicium*.

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Lichen Mapping in the Federal Republic of Germany

By Volkmar Wirth, Stuttgart

With 1 figure

The first efforts to start a grid mapping of lichens in Germany date back to the late sixties. This mapping was restricted to the Black Forest and surrounding regions and was based on a rather low scale grid system with units of approx. 5 km x 6 km ("Meßtischblatt-Quadranten"). In these days the basic map scheme still had to be printed on a private basis. In the meantime interest in lichen mapping has grown significantly and several mapping projects receive financial support by governmental institutions: in the federal states of Baden-Württemberg, Rheinland-Pfalz, Saarland and Schleswig-Holstein.

In Germany identical grids are used for lichen mapping and for the other floristic mapping projects (Wirth & Ritschel 1977, Wirth 1984). The same grid has been adopted in the mapping projects of Czechoslovakia, Austria and the German Democratic Republic. It is a great advantage of this system that the grid units are identical with those of the basic general map of Germany which is available everywhere. The grid size is 6 x 10 geographical minutes, i. e. about 11 km x 12 km. In the lichen atlas of Great Britain grid units of a similar size (10 km x 10 km) are being used. I do not recommend considerably smaller units as they require much more efforts and make homogeneous mapping of large areas difficult. In other words, it is better to map the whole country in a reasonable time, than mapping a few regions in a very detailed manner and others not at all. Assembling information on a very small grid may be justified from a regional point of view but not from a national one. These statements hold true especially for those countries, where lichenology is not given as high a rank as elsewhere.

A historical classification according to records made before 1900, between 1900 and 1950 and after 1950, was recommended in the first appeal for lichen mapping in Germany (Philippi & Wirth 1973). In the atlas of Baden-Württemberg (Wirth 1987) records were assigned to the periods pre-1900, 1900 to 1949, 1950 to 1974 and from 1975 onward. In this case the actualization was important in order to demonstrate the decline of lichens and to make the atlas better usable for the analysis of actual problems. This historical differentiation is recommended as a necessary standard for all other regional mapping projects in Germany in order to ensure the compatibility of the data within a future German lichen atlas. This approach guarantees a still satisfying degree of actuality and considers the fact that most of the data were collected in the period from 1975 onward.

We are using a mapping field list including the names of more frequent and more important lichens. The names of registrated species have to be underlined. Additional species must be noted separately; this is an important psychological drag for all those less experienced in more difficult species. In future we will design a new, more complete list. A checklist of the lichens of Germany is in preparation. At the moment compilation of the data in the different regions is still done manually or

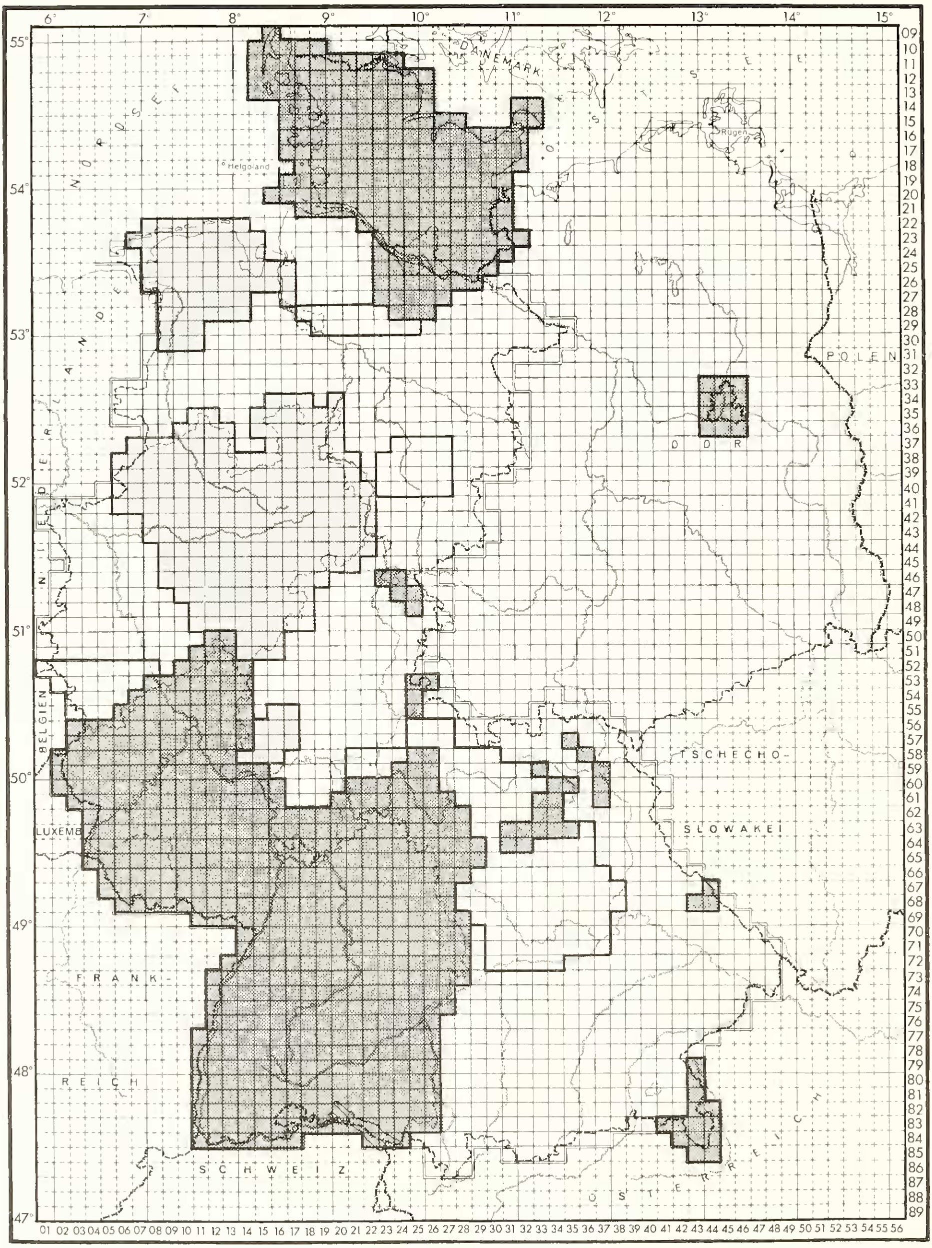

Fig. 1. Grid mapping of lichens in the Federal Republic of Germany. – *Dark grey*: Lichen mapping in advanced state or already finished; – *grey*: Lichen mapping extensive, in progress; – *frames*: only epiphytes or higher lichens mapped. Mapping in single isolated grids is not considered.

aided by computers, using different programs for data management. But a sophisticated computer program for floristical purposes is being developed in Germany.

An overview of the state of regional lichen mapping in the FRG is shown in Fig. 1 and on page 151 (compare also Ernst 1990, Grooten & Woelm 1986, John 1986, 1987, 1990, Kümmerling 1990, Leuckert et al. 1982, Ritschel 1976, 1977, Schneider 1985, Türk & Wittmann 1987, Wirth 1987). Detailed informations on the different regional projects are given in Part III of this volume. Large areas of West Germany (FRG) are not covered by a systematic mapping project. Nevertheless detailed floristic informations are available for many single units in these „white" regions. These grid units are dispersed all over Germany and partially a great amount of data have already been compiled. They have been omitted in Fig. 1.

Additionally many floristic publications exist dealing with localities and regions scattered all over Germany. The demonstration of successful mapping in several parts of this country (e. g. more than 1000 maps have been worked out for SW-Germany) will surely stimulate progress in the "white" areas. Final aim of all lichen mapping in Germany will be a compilation of the data and a publication of an Atlas of the German Lichen Flora. In order to achieve this goal, a methodical mapping by full-time lichenologists in several additional federal states is desirable (Niedersachsen, Nordrhein-Westfalen, Hessen, Bayern) and should be realized by governmental financial support for a period of approximately 5 years. Nevertheless, sufficient data are already available in order to enable Germany to make satisfactory contributions to a European mapping project.

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Lichen Mapping and Remapping in The Netherlands

By Han F. van Dobben and Arjan J. de Bakker, Leersum

With 1 table and 8 figures

1. Introduction

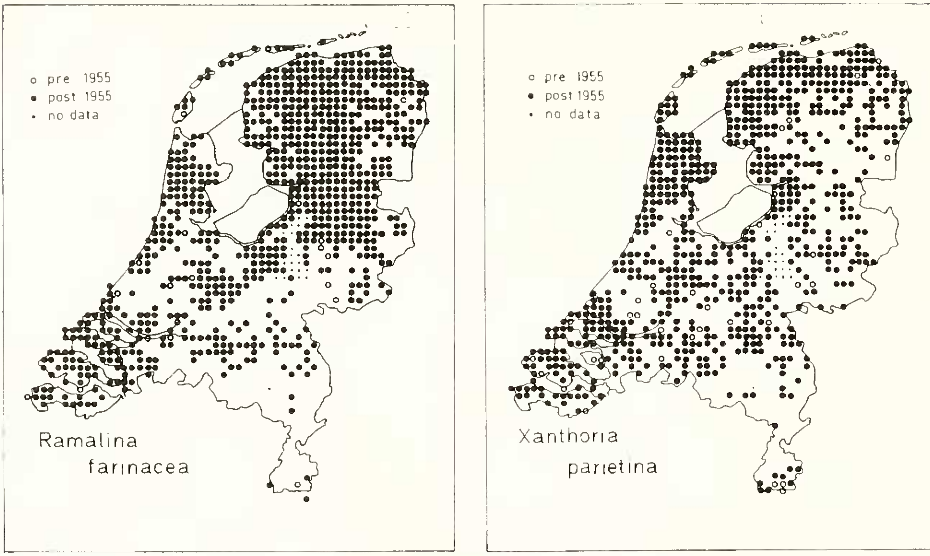
The Netherlands are a lichen-poor country. The poverty is caused by a lack of suitable substrates for epilithic species, especially the acidophytic ones, by a lack of old forest relics, and by a high level of air pollution. There is no systematic, nationwide mapping program of Dutch lichens. However, numerous data collected by various workers provide a fairly good picture of the Dutch lichen flora, and, with respect to epiphytes, of the changes during the past century. The present state of knowledge is summarized in the ‚Standaardlijst van de Nederlandse korstmossen' (Checklist of the Dutch Lichens; Brand et al. 1988), which states ecology and estimated frequency for all species. In this list a total of 665 species is recorded, of which 562 have been found after 1970.

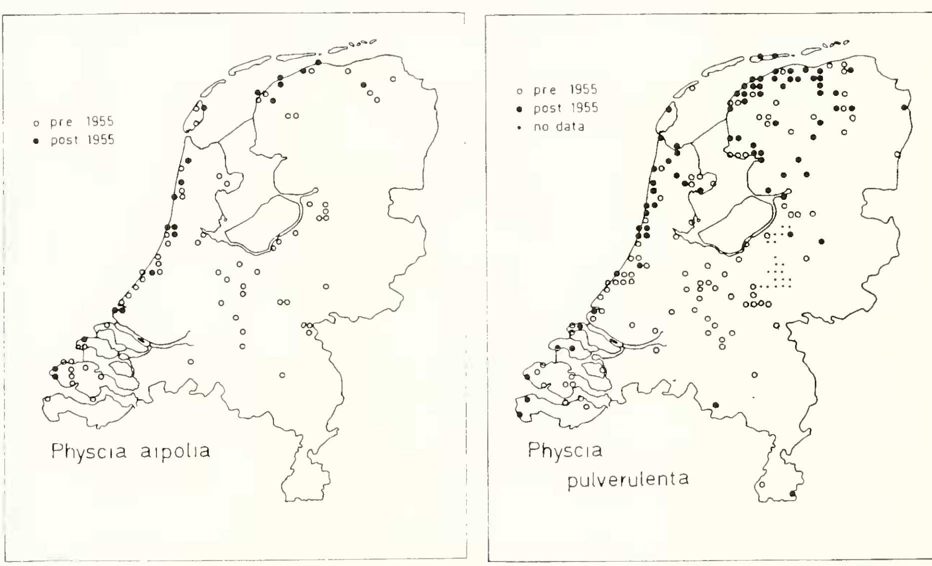
2. The 'WHEN' project

More precise data are available on the epiphytic species. Barkman's (1958) work on the cryptogamic epiphytes of The Netherlands still stands as one of the most important works in descriptive ecology. He was also the first to investigate the effect of air pollution on epiphytic lichens in The Netherlands, and his map has been published many times since, e. g. in Barkman (1969). The relation between epiphytes and air pollution proved to be a great stimulus to the study of this group. Barkman's map was based on relatively few lichen data, and systematic air pollution data were unavailable at that time. However, between 1972 and 1974 the 'WHEN' project (Werkgroep Herkartering Epifytenwoestijnen Nederland; de Wit 1976) was undertaken, a nationwide mapping of epiphytic lichens on the basis of a 5 km x 5 km grid. This inventory was carried out at localities which were chosen randomly within each grid square (c. four per square, most of them wayside trees), by amateurs with a varying degree of experience. The results should be looked at with some caution because field identifications were accepted. Nevertheless, the observed pattern of species richness correlates well with measured SO_2 concentrations. Figure 1 shows the distribution maps of two easily recognizable species, Fig. 3 gives the generalized species richness per square, and Fig. 4 the mean SO_2 concentration measured in 1977.

3. Changes in the epiphytic flora before 1980

Valuable though incomplete information on species distribution in the 19th and early 20th century can be obtained from the material preserved in the Rijksherbarium at Leiden. When these data are compared to the situation after 1950, a strong decline of many species becomes apparent. Examples based on these data are given by Barkman (1958). A comparison of Barkman's data with the WHEN data shows that between 1950 and 1974 further decline took place; Fig. 2 gives two examples (more examples are given by de Wit 1976).





Figs. 1–2. Distribution of several lichen species in the Netherlands (from DE WIT 1976). – 1. (above) *Ramalina farinacea* (left) and *Xanthoria parietina* (right) in the WHEN inventory. – 2. *Physcia aipolia* (left) and *Physconia distorta* (right).

A detailed mapping study in the 's-Hertogenbosch area (c. 20 km x 20 km) by VAN DOBBEN (1983) showed a spectacular decline between 1900 (115 spp.) and 1974 (46 spp.), which could largely be ascribed to air pollution by SO_2 and resulting bark acidification. For most species (except *Lecanora conizaeoides*) naturally acid bark had become too acid, while some common species, e. g. *Parmelia sulcata* and *Evernia prunastri*, survived on naturally neutral, now acidified bark.

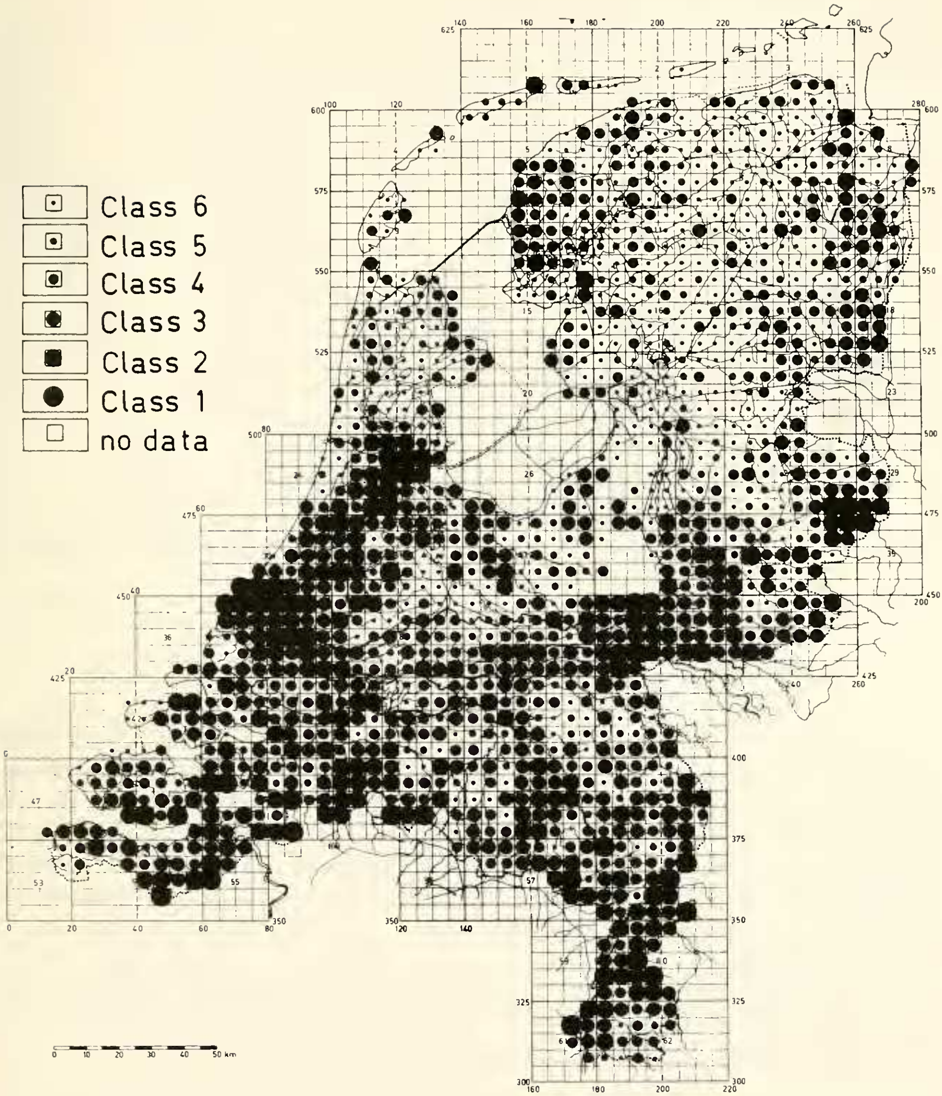
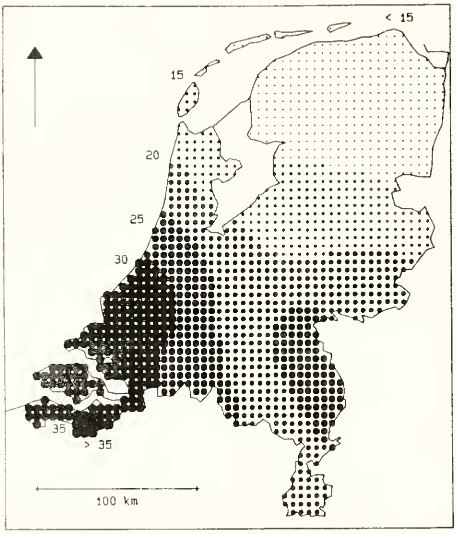


Fig. 3. Species richness per grid square in the WHEN inventory (from DE WIT 1976). – *Explanation* of class numbers:

class	approx. number of species per square	common species
1	0 – 3	*Lecanora conizaeoides, L. expallens*
2	4 – 7	*Buellia punctata, Physcia tenella*
3	8 –11	*Parmelia sulcata, Evernia prunastri*
4	12–17	*Ramalina farinacea, Parmelia acetabulum*
5	17–20	*Ramalina fastigiata, Parmelia exasperatula*
6	> 20	*Parmelia caperata, Ramalina fraxinea*



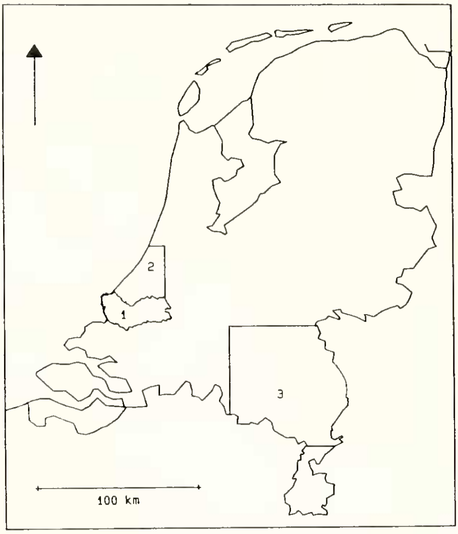


Fig. 4. (left) Mean SO_2-concentration in $\mu g \cdot m^{-3}$ in 1977 (data from National Institute of Public Health and Environmental Protection).

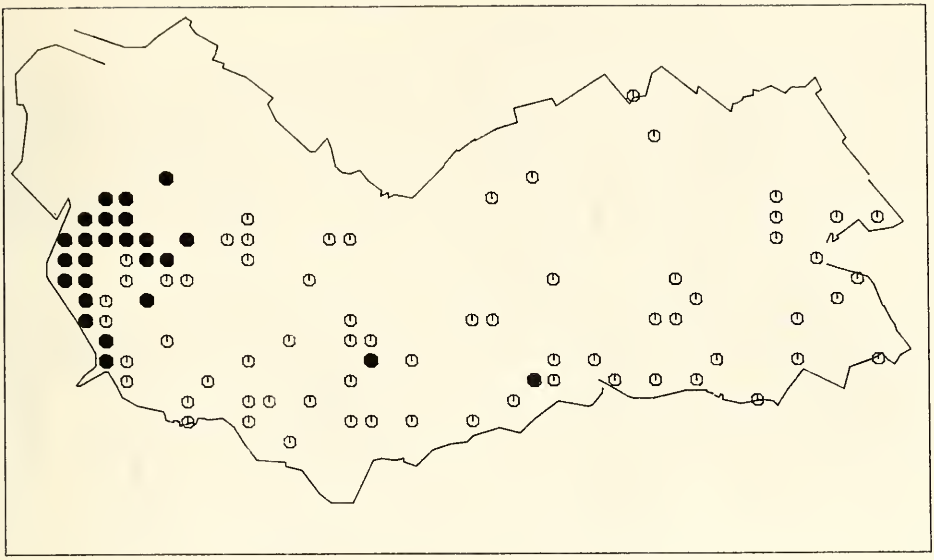
Fig. 5. (right) Location of re-mapped areas: *1* = Rijnmond (industrial), – *2* = Zuid-Holland (industrial and agricultural), – *3* = eastern Brabant (agricultural).

4. Remapping studies

From c. 1970 onward the SO_2-concentration had steadily decreased and it was thought that this might have had a positive effect on epiphyte vegetation. Therefore a number of local remapping studies were undertaken after 1980 (e. g. DE BAKKER 1985, VAN DER KNAAP & VAN DOBBEN 1987, VAN DIJK 1988). In these studies the localities visited in the WHEN project were revisited, and new localities were chosen when former ones could not be tracted. It appeared that many epiphyte species had become more common, in agricultural as well as in industrial areas (Fig. 5, 6, 7). However, nitrophytic species (*Physcia*, *Xanthoria* and *Candelariella* spp.) had increased much more than the other species (Table 1). This increase in nitrophytic species is now ascribed to an emission of NH_3 from intensive cattle husbandry, which has strongly increased over the past few decades (ASMAN et al. 1987).

Table 1. Mean frequency (= number of occurrences as a percentage of number of visited localities) of the nitrophytic species (*Physcia*, *Xanthoria* and *Candelariella* spp.) and the other species, in three re-mapped areas (Fig. 5) in 1973 and 1985. – The *areas* are: Rijnmond (*1*; industrial), Zuid-Holland (*2*; industrial and agricultural) and eastern Brabant (*3*; agricultural).

area →	1		2		3	
year →	1973	1984	1973	1984	1973	1984
no. of localities	565	689	680	902	1439	1202
mean freq. nitr. spp.	5.3	8.9	1.6	5.6	8.4	16.5
mean freq. other spp.	4.7	5.8	3.6	4.8	6.0	6.0



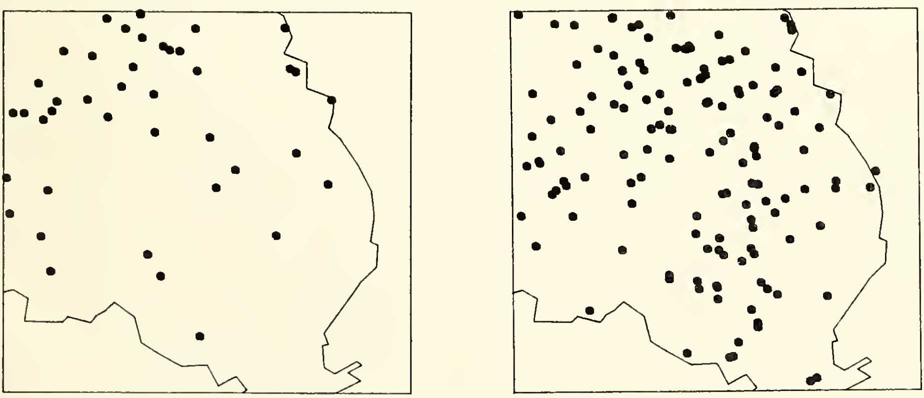
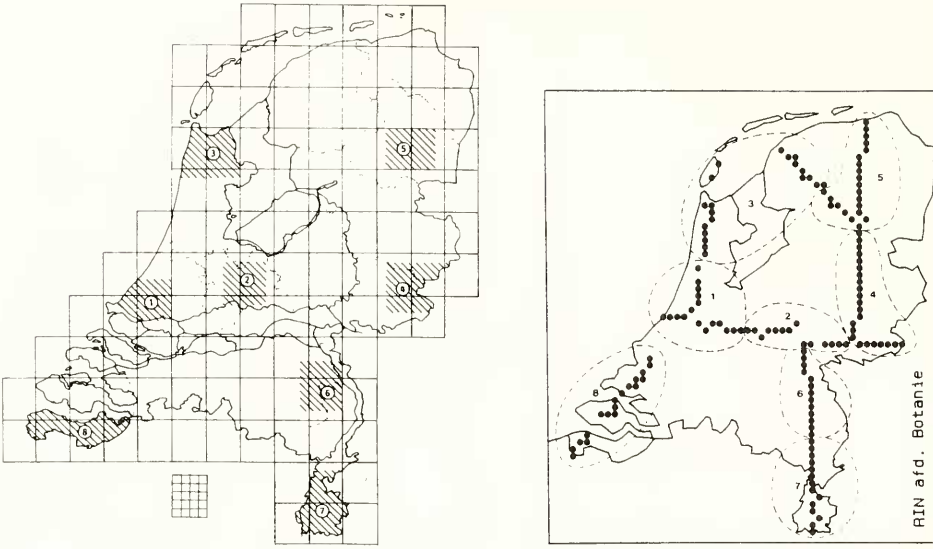


Fig. 6. (above) Distribution of *Evernia prunastri* in the Rijnmond area on a 1 x 1 km² grid basis. – *Closed* circles = 1973, *open circles* = 1984.
Fig. 7. Distribution of *Physcia adscendens* in eastern Brabant in 1973 (left) and 1986 (right).

In one of the local studies (DE BAKKER & VAN DOBBEN 1988) the pH and nitrogen content of bark samples were measured. Nitrophytic species appeared to be favoured by a high bark pH rather than a high nitrogen content. Therefore, the decrease in SO_2-concentration, leading to less bark acidification, is also favourable for nitrophytic species. As a result, species like *Physcia adscendens*, *Ph. dubia* and *Xanthoria polycarpa* have increased strongly, especially in areas where intensive cattle husbandry is common (Fig. 7). A phenomenon that is not quite understood yet is the appearance of species in these areas which are not notably nitrophytic and have always been rare in The Netherlands, like *Physcia stellaris* (DE BAKKER 1987).



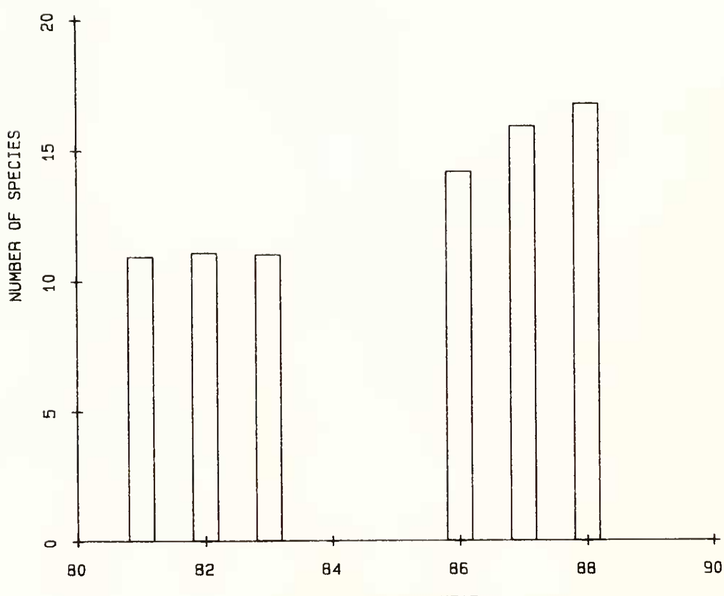


Fig. 8. (above) Epiphyte monitoring network; areas (left) and transects (right).
Fig. 9. (below) Number of species per row of 10 wayside trees as a function of time (2 transects, 104 rows in total).

5. Monitoring

Since 1981 monitoring of epiphytic lichens takes place at fixed stations (rows of 10 wayside trees, mostly *Quercus robur* and *Populus* spp.) as a part of the Dutch air quality monitoring program (DE BAKKER 1988). The monitoring stations (ca. 1350) are located in eight areas around chemical monitoring stations and in a number of transects through the country (Fig. 8). The time series that now exist for some of the transects clearly show the increase in species richness after 1980 (Fig. 9).

6. Summary and conclusions

The Netherlands are a lichen-poor country. Decreasing SO_2-concentrations and increasing NH_3-concentrations have caused an expansion of many of the more common epiphytes, especially the nitrophytic ones, during the past decade. Nevertheless, the epiphytic flora is still poor compared to the situation existing around 1900, and a return to that state cannot be expected in the near future, despite strong intentions of the government to further reduce both SO_2 and NH_3 emmission.

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Mapping Lichens and Lichenicolous Fungi in Belgium and Luxembourg

By Paul Diederich, Luxembourg and Emmanuël Sérusiaux, Liège

With 2 figures

1. Introduction

The lichens and lichenicolous fungi of Belgium and Luxembourg have been studied since the beginning of the last century. The first important lichenologists were Clément Aigret, Jean Kickx, Marie-Anne Libert, Louis Marchand and Francois Auguste Tinant. At the end of the 19th century two surveys were published including the available information on lichens of Belgium (de Wildeman 1898) and Luxembourg (Koltz 1897). In 1938 a checklist of the Belgian lichens appeared, listing 586 species, but no chorological or ecological synthesis has been attempted (Duvigneaud & Giltay 1938).

In 1958 Jacques Lambinon began important investigations on macrolichens and prepared distribution maps for all species, except for *Cladonia* (Lambinon 1966, 1969). More recently Wagner-Schaber (1987) published distribution maps of 55 species of epiphytic macrolichens in Luxembourg.

Since 1980 we have focused our attention on microlichens and on lichenicolous fungi, and one of us presented distribution maps of 240 Luxembourgish epiphytic species in his Ph. D. thesis (Diederich 1989).

The data available from herbarium specimens, field observations and literature are now being fed into a computerized database in view of future applications like the publication of an annotated checklist or of a distribution atlas.

2. The computerized database

A computer program has been developed by P. Diederich (see this vol.) written in Turbo Pascal for floristic and faunistic databases. The following information is stored:

Country,
subdivision of the country,
locality,
geographical coordinates,
altitude,
date of collection or of observation,
ecology,
frequency,
references (observer, collector, collection, number, etc.),
publication dealing with the data,
comments,
certainty of data (doubtful or sure),
species.

The program offers facilities such as printing distribution maps on screen and printer (Fig. 1), preparing reports for inclusion by a word processor in manuscripts, answering complex questions, etc.

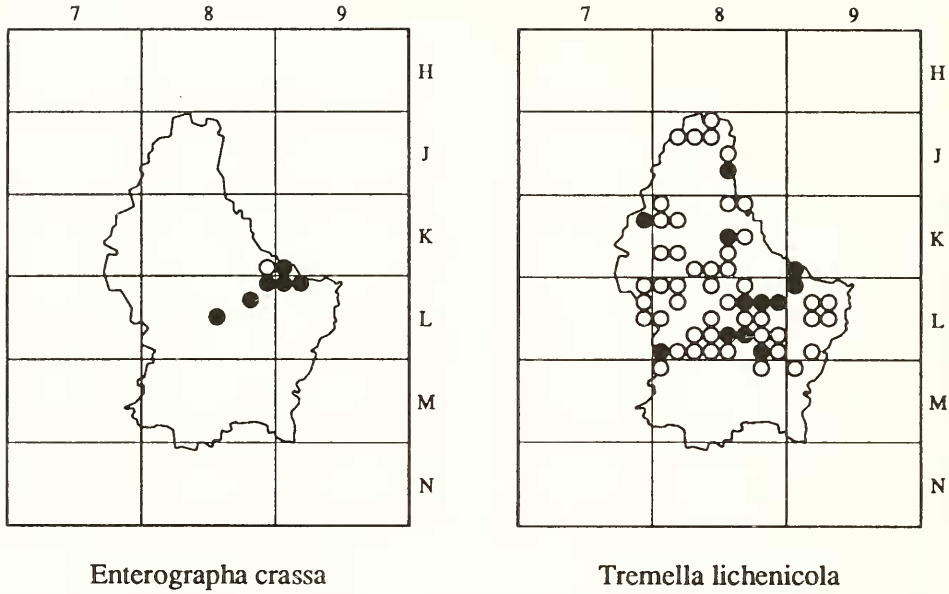

Fig. 1. The distribution of the lichen *Enterographa crassa* and of the lichenicolous fungus *Tremella lichenicola* in Luxembourg. – *Black disks* represent herbarium specimens; *white disks* represent field observations. – Both maps have been printed by computer.

3. The mapping grid

The phanerogamic flora of Belgium and Luxembourg has been mapped using a national grid system called I.F.B.L. ("Institut Floristique Belgo-Luxembourgeois") with squares of 4 km x 4 km subdivided in squares of 1 km x 1 km (Fig. 2). For practical reasons this system has also been adopted for lichens; the 10 x 10 km^2 square in the U.T.M. grid is calculated for every locality by the computer, allowing compatibility with international mapping schemes.

4. Aims

(a) In 1993 we plan to have a complete database on lichens and lichenicolous fungi in Belgium, Luxembourg and the "Département des Ardennes" in northern France. For that purpose all old herbaria will be studied critically, and the most interesting localities and sites will be investigated carefully.

(b) At the same time an annotated checklist of the taxa including chorological and ecological data will be published.

(c) A distribution atlas will be available on computer. Maps of selected species or a complete atlas will probably be published.

5. Acknowledgements

We wish to thank Mr. Jean Krier for revising the English text of the manuscript.

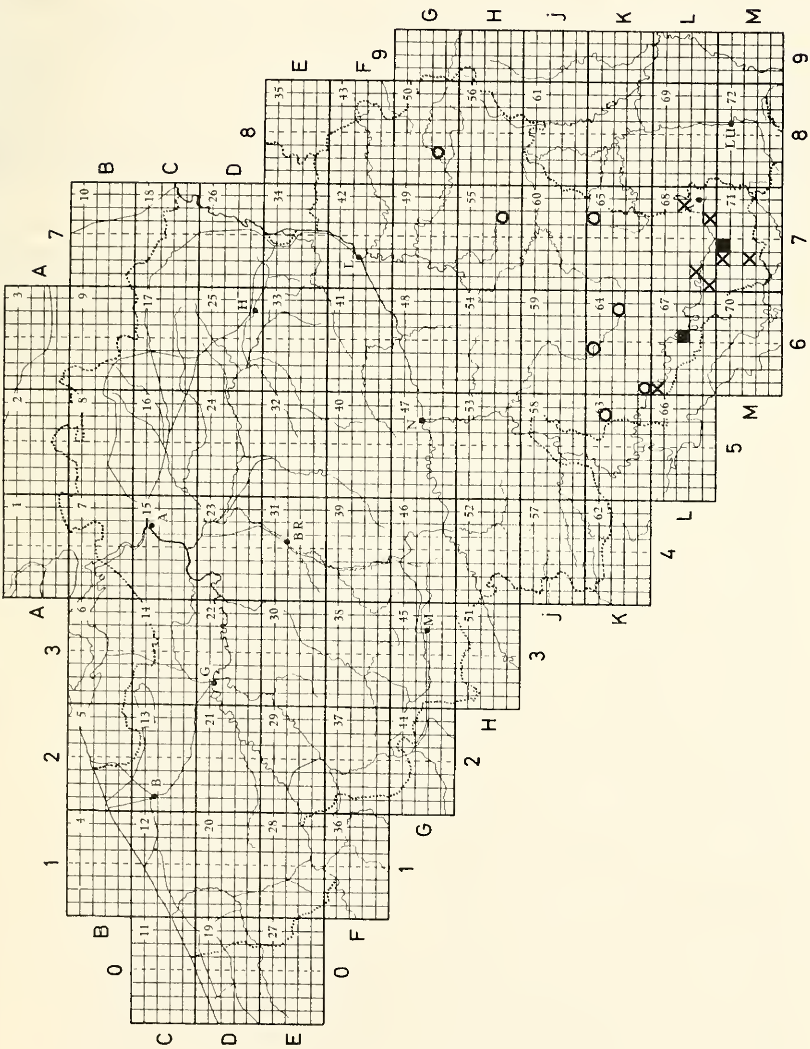

Fig. 2. The distribution of *Lobaria scrobiculata* in Belgium and Luxembourg. – *Circles* represent data before 1910; *crosses* represent data from the period 1910–1970; *black squares* represent data after 1970.

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Lichen Mapping in France

By Michel Lerond, Rouen

With 3 figures and 1 table

Three groups of authors are participating in the production of a distribution atlas of lichens in France. The promoter of the project is the Association Française de Lichénologie (A.F.L.), data processing is managed by the Secretariat Faune-Flore at the Museum National (S.F.F.) and the co-ordination is done by the CDM, Observatoire Régional de l'Environnement. At the moment field work is restricted to only 12 collaborators, being located in the northern, central, south-eastern and central south-western parts of the country.

The mapping project developed in five stages. In 1973 mapping began in the Region Nord, aiming at pollution monitoring. This mapping was restricted to 30 species and based on a very low scale grid system.

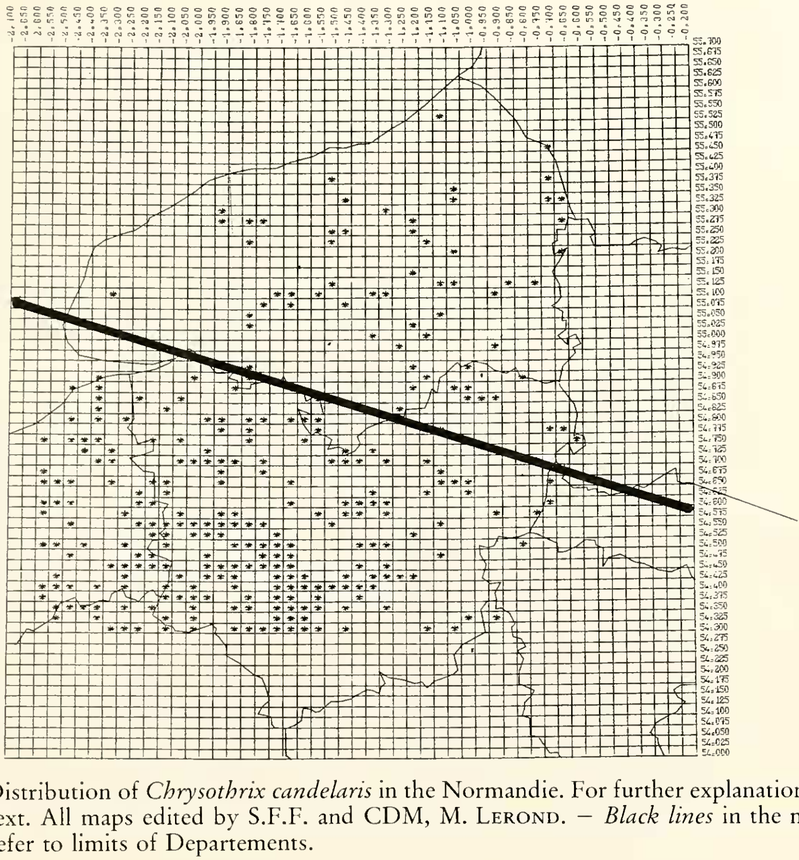

Fig. 1. Distribution of *Chrysothrix candelaris* in the Normandie. For further explanation see text. All maps edited by S.F.F. and CDM, M. Lerond. – *Black lines* in the maps refer to limits of Departements.

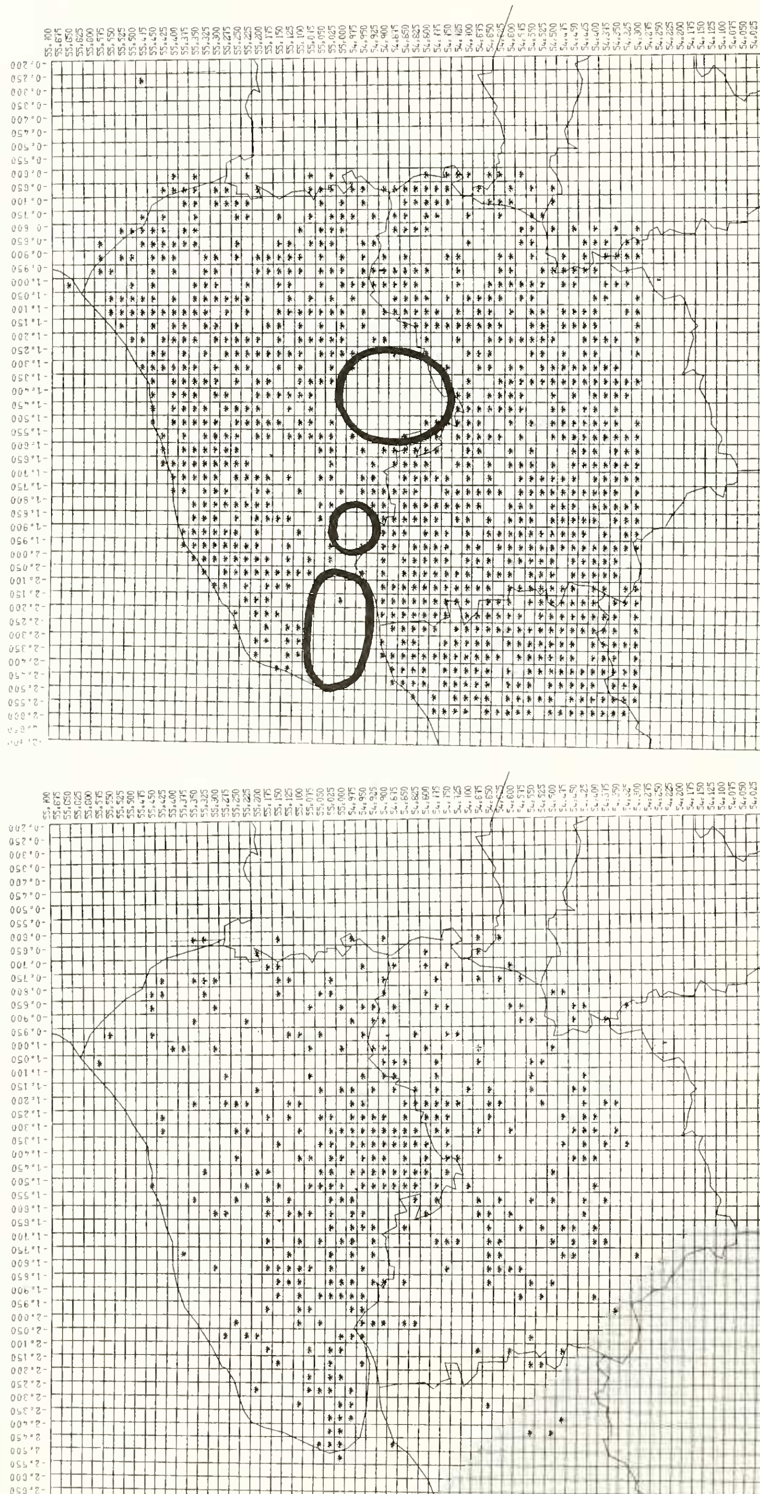

Fig. 2–3. Distribution of two lichen species in the Normandie. – 2. (left) *Lecanora conizaeoides.* – 3. (right) *Parmelia caperata.*

In 1983 an experimental program covering the area of Haute-Normandie was started. This project used a very low scale grid system, too. A total of 135 species were mapped with regard to chorology and pollution monitoring. The distribution map (Fig. 1) of *Chryosthrix candelaris* evidently shows river Seine to form a phytogeographical borderline of the area of this species. Other distribution maps resulting from this project are those of *Lecanora conizaeoides* (Fig. 2), an example of a highly toxitolerant species, and of *Parmelia caperata* (Fig. 3), which reflects the influence of air pollution on the disappearance of this species.

Table 1. The 30 species selected for distribution mapping in 1986 [taxonomy following Clauzade & Roux 1986, except for *Psora scalaris* = *Hypocenomyce scalaris* (Ach.) Choisy].

1 *Anaptychia ciliaris*	16 *Parmelia revoluta*
2 *Bryoria fuscescens*	17 *Parmelia soredians*
3 *Buellia punctata*	18 *Parmelia tiliacea*
4 *Cetraria chlorophylla*	19 *Parmeliopsis ambigua*
5 *Cladonia rangiferina*	20 *Pertusaria amara*
6 *Diploicia canescens*	21 *Physcia aipolia*
7 *Hypogymnia bitteriana*	22 *Physcia clementei*
8 *Lecanora conizaeoides*	23 *Physconia grisea*
9 *Lecanora expallens*	24 *Platismatia glauca*
10 *Lobaria pulmonaria*	25 *Pseudevernia furfuracea*
11 *Normandina pulchella*	26 *Psora scalaris*
12 *Parmelia acetabulum*	27 *Pyrenula nitida*
13 *Parmelia caperata*	28 *Teloschistes chrysophthalmus*
14 *Parmelia perlata*	29 *Xanthoria parietina*
15 *Parmelia reticulata*	30 *Xanthoria polycarpa*

In 1986 a choice of 30 species (Tab. 1) was selected for mapping and it was also decided to follow the taxonomy applied by Clauzade & Roux (1986). The first data sets were completed in 1987 and in 1989 500 data sets were processed. Until now areas in the north-western part of the country, in the French Alps and in the Bordeaux region have been mapped.

Literature

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Lichen Mapping in Spain and Portugal

By José M. Egea, Murcia

With 2 figures

At present no official lichen mapping projects concerning the Iberian Peninsula and Northern Africa are existing. It may still take a long time of planning until such a project can be started seriously. Knowledge of lichen distribution in Spain is actually restricted to some areas close to research centres and almost half of our country still remains lichenologically unexplored. Moreover, this information refers only to a selection of substrates.

Data compiled in any available map in Spain are originating from taxonomic work or from floristic and phytosociological studies carried out on a regional scale. There is no attempt of mapping lichen distribution on a paniberian scale.

Until now the following maps are available compiled from data collected by the research team under my direction:

(1) Distribution maps of 122 species plus 7 varieties growing on volcanic and other siliceous rock substrates at low altitude in SE Spain.

(2) Maps showing the world wide distribution of a large number of species belonging to *Heppia* and *Peltula* have been designed in connection with taxonomic studies dealing with western European and northern African species of these two genera.

(3) Distribution maps of all lichen species belonging to the families Opegraphaceae and Lichinaceae in SE Spain have resulted from two doctoral theses completed recently.

(4) Furthermore, distribution maps of the characteristic species forming ombrophobous communities of seashores in Northern Africa and Western Europe are available, too (Fig. 1).

Unfortunately, methods of data collection applied in the different studies have not been uniform. Data resulting from regional studies are being presented in maps showing distribution at different levels of altitude whereas exact reconstruction of locations from larger scale distribution maps often fails.

On the other hand, verification of a majority of the bibliographical data proves to be rather difficult. We have therefore based our maps on our own data, collecting herbarium specimens if possible. Literature has been taken into consideration in the case of *Heppia* and *Peltula* only, using the recent revisions of these genera by Wetmore (1970) and Swinscow & Krog (1979).

Our group, in cooperation with my collegues from Murcia and J. Rowe (Sevilla), has been starting a new project titled “Comparative biogeography of the seashore lichen flora of the Iberian Peninsula and Morocco”, supported by the Spanish Government. This project continues preceeding studies on lichens of seashores situated between Cabo de Gata (Almeria) and Cabo de Creus (Barcelona) recently finished in collaboration with some investigators from Barcelona.

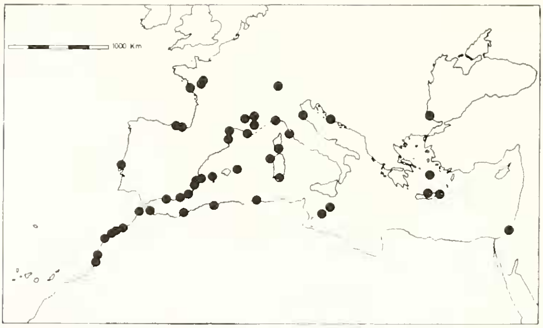

Fig. 1. Distribution of *Lecanactis grumulosa* (Duf.) Fr. var. *grumulosa* in the Mediterranean region.

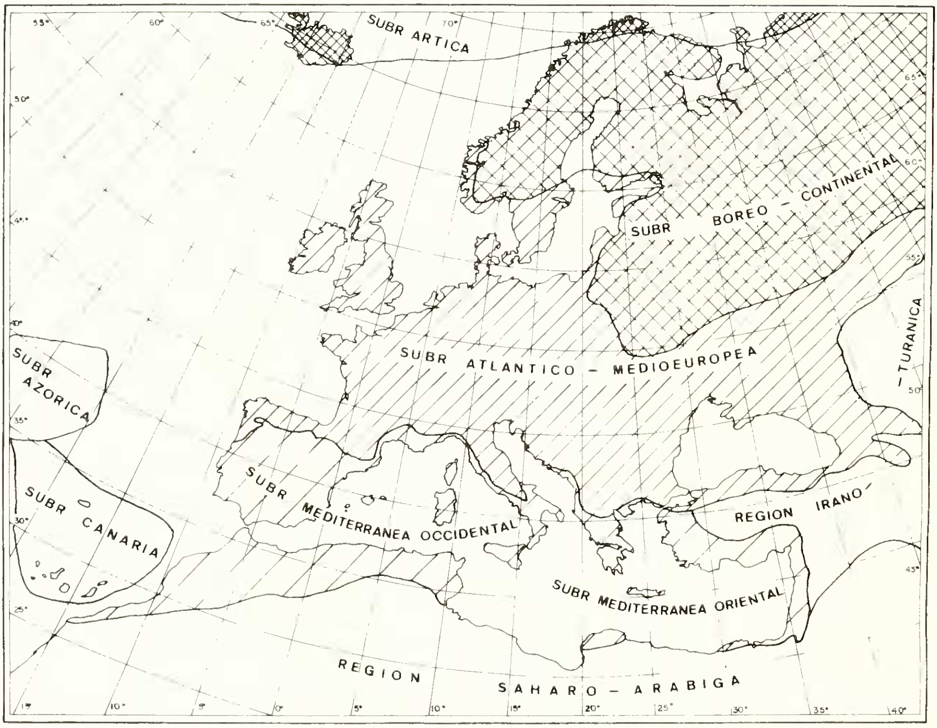

Fig. 2 Bioclimatical regions and subregions of Europe and Northern Africa.

The main objects of the new project are the mapping of the most interesting species, investigations on a correlation between lichen flora and biogeographic belts and a taxonomic revision of the *Pertusaria* species occurring in the described area.

We are using a biogeographical map (Fig. 2) subdivided into subregions. Terminology and limits of chorologic units follow MEUSEL et al. (1965), modified recently by RIVAS-MARTINEZ (1987). Main differences between the two cited schemes are:

(1) Parts of the circumarctic and circumboreal regions are included in the Eurosiberian region.
(2) The submediterranean subregion is subordinated to the atlantic-centroeuropean subregion and excluded from the mediterranean region.
(3) The macaronesic-mediterranean region is divided into two independent regions, which themselves are subdivided into two subregions respectively.

In the studies of lichen distribution in Spain we are going to use a map which includes all of the different bioclimatic belts.

Finally, in my opinion, it would be of great interest to include biogeographic and bioclimatic maps of the whole of Europe in a future atlas of the European lichen flora. Main problems yet to be solved are general agreements on limits of chorological units and on the most useful indices necessary for a correct delimitation of bioclimatic units.

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Perspectives for the European Lichen Mapping Project in Italy

By Mauro Tretiach, Trieste

1. Introduction

In the last century an important lichenological school originated in Italy, led by G. DE NOTARIS and A. MASSALONGO, who proposed the use of micromorphological characters for the delimitation of taxa (see HALE 1984). In the same period other Italian lichenologists, as F. BAGLIETTO and A. CARESTIA carried out floristic investigations in several parts of the country. The interest in cryptogamic research was so high that in 1858 a group of scientists and amateurs founded in Genova the Società Crittogamologica Italiana. The newborne society published an official paper, the Commentario and an important series of exsiccata, the Erbario Crittogamico Italiano. Fundamental studies were published in this period, but the death of MASSALONGO, the dispersion of the group working with DE NOTARIS after he went to Rome, and an unfortunate cultural policy of the Italian Government caused a rapid decline of the Italian lichenological school (NIMIS 1989). The result was, that for almost seventy years (from 1911, when JATTA published his Flora, to 1980) lichenology in Italy was represented by very few people, most of whom were amateurs. In this period no more than 12.000 specimens were collected in Italy, which is only 6% of the whole number of samples preserved in Italian herbaria (TRETIACH & VALCUVIA PASSADORE 1990). The best lichenologists active in the present century were G. GRESINO, C. SBARBARO and M. CENGIA SAMBO. These authors were not university professors; the absence of an academic tradition was one of the main reasons why lichenology in Italy remained neglected for more than fifty years.

In 1987, under the stimulus of P. L. NIMIS, a small group of lichenologists met at Trieste to found the Società Lichenologica Italiana (S.L.I), whose main aim is the improvement of lichenological research in Italy. In about two years, the Society has organized 10 introductory courses to Lichenology, one International and one National Symposium, and a good number of excursions in various parts of the Peninsula. The official Society organ is the Notiziario, published once a year. Although a young society, the S.L.I. has now grown to more than 180 members. For the first time, since 1988, the Italian Government is funding a National Research Program on Lichens, involving 10 Universities throughout the country.

The recent renaissance of lichenological activity in Italy gives hope that the European Lichen Mapping Project can be extended to this country. Information for lichen mapping in Italy can be gathered from three different sources: herbaria, literature, and direct recording of species in the field.

2. Herbaria

The herbaria are excellent sources of information for phytogeographic studies. In my opinion, distribution maps of species should be based, if possible, on specimens preserved in collections, at least when difficult taxa are concerned. The herbarium

specimens allow validation of the identifications, and can be used for further investigations, such as chemical, ultrastructural or histological analyses for systematic revisions.

All too often the herbaria are considered as dusty, useless warehouses. Many of the Italian lichen herbaria are actually dusty warehouses, even if they preserve about 200.000 samples (most of them collected in the last century).

The main problems in obtaining information from Italian herbaria are: (a) the lack of recent revisions of old specimens; (b) the lack of an efficient herbarium staff, so that the requests of loans remain unanswered; (c) scarcity of updated information on the contents of herbaria. The historical herbaria, for example those of F. Baglietto (MOD), A. Jatta (NAP), G. de Notaris (RO), are particularly affected by these problems.

The results of a recent survey of the Italian herbaria, promoted by the S.L.I., have been edited by Tretiach & Valcuvia Passadore (1990). The survey concerns all the historical collections, with the exception of the herbarium of V. Trevisan, and gives an estimate of their holdings. The location of the types of all lichen taxa described by Italian authors is planned for the future.

In the last ten years some new herbaria have been created; a few of them have been computerized, such as the lichen herbarium of the University of Trieste (TSB, Herb. P. L. Nimis), with more than 14.000 samples, and the Herbarium of the Università della Calabria (CLU, Herb. M. Codogno & D. Puntillo), with about 8.000 samples. Other new collections, such as those of G. Caniglia, R. Piervittori, M. Valcuvia Passadore, D. Ottonello, M. Grillo are inserted within the historical herbaria of PAD, TO, PAV, PAL, CAT, respectively.

The P. L. Nimis Herbarium (TSB) contains personal collections from Alaska, Svalbard, Canary Island, Tierra del Fuego and Italy; the Italian samples were collected mainly in Friuli-Venezia Giulia, Sardinia, Latium, with a mean annual increase rate of 1.400 samples. This herbarium constitutes the basis for a databank, the basic archives (list of species and localities with ecological data) of which is printed once a year, and is available upon request. The software of this databank is described by Lagonegro et al. (1982). For each herbarium specimen, the following information is stored: (a) progressive number of herbarium envelope; (b) geographic sectors; (c) quadrant number, with the grid adopted in the Project of Floristic Cartography of Central Europe; (d) substrate type, as follows: 1) rock type; 2) soil type; 3) tree species or genus; (e) elevation. Such information is integrated with those obtained by Wirth (1980), concerning the ecological range of the species, as follow: pH-range; eutrophication range; moisture range; light range, and with the area diagnosis in Europe, also taken from Wirth (1980). It is possible to obtain species lists for localities or quadrants, frequencies of species with respect to elevation or substrate-type and distribution maps from this databank. The software allows obtaining matrices with the frequencies of species with the same distribution patterns, or with the same ecological requirements, within geographic sectors, quadrants, or different localities. These matrices can be processed by methods of multivariate analysis. Examples of such an approach are given in Nimis & de Faveri (1980), Nimis & Losi (1983), Nimis et al. (1987). Although the floristic investigation is far from being completed, the publication of a first distribution atlas covering Northeastern Italy is planned within the next few years. The software of the databank will be changed in 1990 in

correspondence with the substitution of the hardware at the Centro di Calcolo of the Trieste University.

Other computerized lichen collections are those of PAL and CLU, the basic archives of which can be requested from the authors.

3. Literature

Literature may be a good source of floristic information, but its use may be dangerous, above all when it is not possible to check dubious identifications. Moreover, old literature records are sometimes inadequate for mapping purposes, since they often require a critical reappraisal of old nomenclature.

In Italy good floristic investigations were carried out by BAGLIETTO (1863), BAGLIETTO & CARESTIA (1863, 1865, 1867, 1880) in the Valsesia (Western Alps), MORIS & DE NOTARIS (1839) on the Isle of Capraia (Tuscan Archipelago), by BAGLIETTO in Tuscany (1871) and Sardinia (1879), ANZI in the Rhaetian Alps (1860), etc.

All these publications are usually based on samples preserved in the Italian herbaria, so that it is possible to check the identifications if necessary. NIMIS & POELT (1987), for example, critically discuss the species cited by BAGLIETTO (1879) for the flora of Sardinia. VALCUVIA PASSADORE & VITTADINI ZORZOLI (1982) compiled all the available information on lichens reported by previous authors (F. BAGLIETTO, M. L. J. BOULY DE LESDAIN, G. DE NOTARIS, A. JATTA, C. SBARBARO, M. J. SERVIT) from Liguria, without attempting a critical revision.

The Flora of JATTA (1909–1911) remains the most complete work on the lichen flora of Italy, but it can hardly be used for mapping purposes, since the locality records are extremely vague.

The S.L.I. is organizing a documentation center to improve the availability of old literature. The reprint of rare articles of the Masters of Italian lichenology is also in progress: the first volume will be published in 1990 with a selection of papers by A. MASSALONGO.

In the last years, floristic contributions were published in the series "Contributions to lichen floristics in Italy", with the papers on the M.te Ventasso (Northern Apennines; NIMIS 1985a), on the Tremiti Islands (Southern Adriatic Sea; NIMIS 1985b), on the Presidential Estate of Castelporziano (Latium; NIMIS 1988), on the Caronte Valley (Calabria; PUNTILLO 1987), and on the Isle of Capraia (Tuscan Archipelago; NIMIS et al. 1990). The main aim of the series is to study the floras of small, well delimited areas such as islands, single mountains or old forests. Other floristic lists have been published by CANIGLIA et al. (1985) and CANIGLIA & DE BENETTI (1987) on the Cansiglio Plateau (NE Italy); CASTELLO et al. (1989) on the epiphytic flora of the upper Torre Valley (Julian Prealps); GRILLO & ROMANO (1988) on the National Park of Abruzzi (Central Italy), GRILLO & CANIGLIA (in press) on the flora of Etna Volcano; NIMIS & LOI (1982a) on the Val Rosandra, near Trieste; NIMIS & LOI (1982b) on the epiphytic flora of the Trieste Karst; NIMIS et al. (1987), on the epilithic flora of archeological sites in Latium; NIMIS & POELT (1987) on the lichen flora of Sardinia; OTTONELLO & MERLO (in press) on the Isle of Marettimo (Egadi Islands). By comparing the results of these studies it will be possible to study the correlations between climatical factors and distribution patterns, floristic diversity and structural features of the floras. These species lists will be a good source of information for mapping projects.

The best distributional data which can be obtained from the literature are those contained in taxonomic revisions of given taxa, or in studies specifically devoted to the analysis of distribution patterns, which summarize the analysis of several herbarium specimens, field collections and literature data. In the last few years some revisions of Italian material were published by Coassini-Lokar et al. (1986, 1987) on the *Cladonia chlorophaea-pyxidata* complex and on the genus *Parmotrema*, Codogno et al. on the *Umbilicaria hirsuta* complex in Europe (1989), and Codogno & Puntillo on the Pannariaceae of Calabria (in prep.). Phytogeographic contributions are those of Tretiach & Nimis (1988) on the distribution of *Normandina pulchella* in Europe, Codogno & Puntillo on the Umbilicariaceae in Calabria (in press), Codogno & Sancho on the Umbilicariaceae in the W-Mediterranean basin (in press).

4. Field investigation

The relatively high number of S.L.I. members could allow extension of lichen mapping to the whole peninsula, at least for easily recognizable species. At present, the S.L.I. and the Italian W.W.F. have launched a national project for the introduction of a simplified method for monitoring air pollution with lichens in the Italian schools, inspired by the method proposed by Herzig et al. (1989). In 1989, 30 schools, in different towns throughout the country have been involved; in the next year they should be almost 200. There is a S.L.I. specialist in each region to assist the teachers in the identification of lichens. This project could be a good source of information on the distribution and behaviour of species endangered by air pollution, because the data will be collected at the national level and published in the Notiziario of the S.L.I. The rapid increase of applied research in biomonitoring with lichens could also be of interest for mapping purposes; at the moment there are several projects in progress in different parts of Italy, which include the mapping of all epiphytic lichen species around towns, industrial areas, or over relatively vast regions. The most important project is the study of the whole Veneto region commissioned by the local authorities to the University of Trieste. More than 500 localities have been visited, and in each locality the frequency of all epiphytic species on several trees (*Tilia*) have been recorded. The results have been processed by programs of authomatic mapping, producing the distribution maps of more than 100 species; the maps report also their frequency distribution in the survey area. These data could be directly used for the European Lichen Mapping Project.

The S.L.I. organizes common excursions in the Italian Peninsula every year, like those in Calabria (1988), Capraia and Castel Porziano (1989), to study areas with lichen floras not well known. The data gathered at these occasions could also be used for mapping purposes.

Finally, in 1989, a Lichen Commission was established within the International Organization for the Phyto-Taxonomic Investigation of the Mediterranean Area, whose first meeting will be held in Trieste in April 1990. The main aim of this commission is the compilation of a first check-list of Mediterranean lichens. Field studies will be organized by the Commission in the least explored parts of the Mediterranean Region, including Italy; these should provide very important distributional data to fill the apparent distributional gaps of some species in some poorly investigated parts of Southern Europe.

5. Conclusions

The loss of the old lichenological tradition caused a major delay in the development of floristics and phytogeography of lichens in Italy. Nowadays, lichenological studies are rapidly increasing after more than half a century of almost complete neglect. Floristic mapping projects not only have a scientific importance in themselves; they also provide a framework to organize the activity of people working in the same country. In this sense I think that the involvement of the Italian Lichen Society in the European Lichen Mapping Program could be very fruitful.

6. Acknowledgement

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Lichen Mapping in Jugoslavia, especially in Slovenia

By Franc Batič, Ljubljana

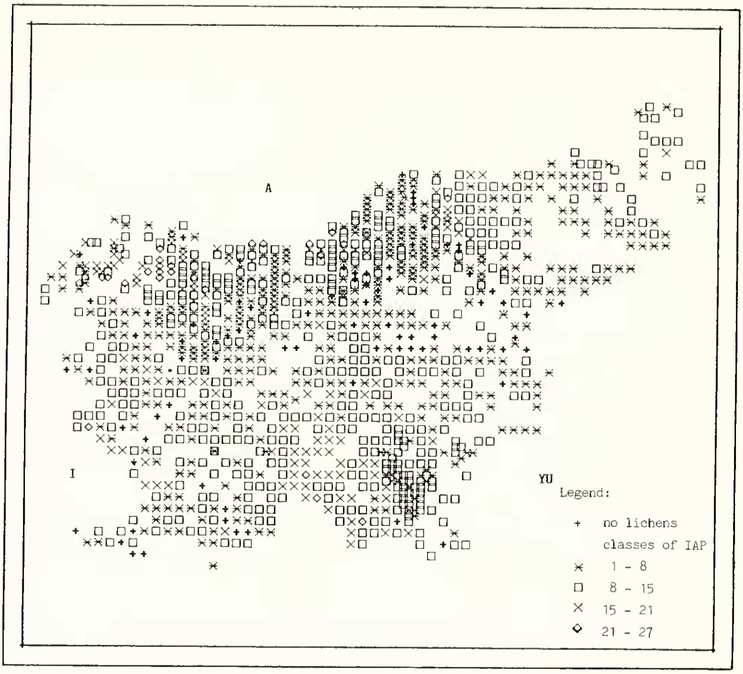
With 2 figures and 1 table

The state of the knowledge on the lichen flora of Slovenia as well as of other parts of Yugoslavia is rather bad. Since the death of Fran Kušan, the famous Croatian lichenologist, who had compiled data on Yugoslavian lichen species with respect to both foreign sources and his own fieldwork, we have not had any better trained lichenologist. Therefore Kušan's work (Kušan 1953) remains the only reliable source on the lichen flora in Yugoslavia.

The lichen flora of Slovenia was mainly investigated by foreign lichenologists of whom Glowacki & Arnold (1874) and Zahlbruckner (1922–34) were the most important ones. Unfortunately these lichenologists visited only a few well known localities which are cited by Kušan again. The greater part of the country remains uninvestigated.

Air pollution problems which have arisen during the last twenty years led to an increased interest in lichens. Epiphytic lichens of some more polluted regions were mapped (Batič et al. 1979, Batič & Martinčič 1982) and taxonomic work on lichens slowly started again. Interest for lichens increased in connection with growing knowledge on their sensitivity to air pollution. Between 1975 and 1979 the Panslovenian Youth Research Program mapped the whole area of Slovenia, considering the distribution of different epiphytic lichen growth forms (Batič et al. 1984). A simple lichen map was constructed. Interest for lichens as air quality indicators increased again in connection with forest decline studies. As we had once more not enough trained lichenologists, very simple methods of air quality bioindication on forest damage inventory plots were applied (Batič & Kralj 1989). Three main thallus types of epiphytic lichens, i. e. crustose, foliose and fructicose were registered. The frequency, coverage and height of growth on the tree trunk of the dominant tree species were assessed for each growth form group. A lichen map of Slovenia was constructed from these data (Fig. 1, 2). It reflects the general state of air pollution in our republic. That kind of lichen inventory was performed twice in the years 1985 and 1987 on the 4 km x 4 km grid of forest damage inventory plots consisting of 1125 units. At the same time we are proceeding with lichen mapping on the 16 km x 16 km bioindication grid system used in forest decline research. The aim of this work is to obtain the basis of lichen distribution in our forests and to improve bioindication of air pollution with epiphytic lichens. First of all we are going to map some macrolichen species, later on the whole flora. We are still facing problems in the identifications of microlichens and very little work has been done on the epilithic flora.

In Yugoslavia there is a strong interest in the use of lichens as bioindicators but much less in taxonomic work. At present there is no full time lichenologist in the whole country. Therefore progress in lichen mapping will be very slow. Because of



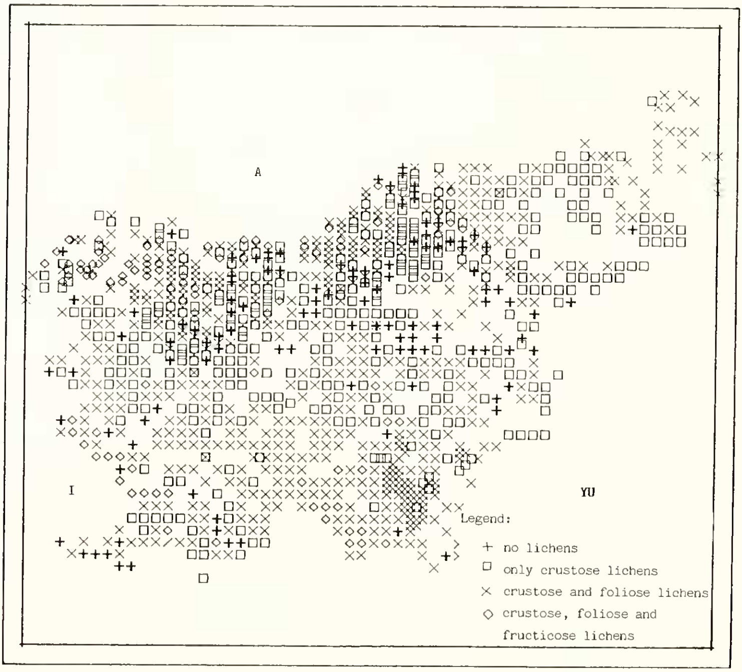


Fig. 1. (above) Lichen map of Slovenia based on IAP values (index of atmospheric purity), using data from the 1987 forest decline inventory.

Fig. 2. (below) Lichen map of Slovenia showing presence and distribution of lichens with different thallus types.

growing air pollution in our country some species may disappear before ever having been recorded in our flora. The installation of filter equipments on major sulphur dioxide emission sources is planned for 1993. Already now the epiphytic lichen vegetation of our country is quite endangered. We have noticed a major decline or even disappearence of pollution sensitive species, and even the more resistant ones clearly show symptoms of damage. As we have only a few early lichen records it is difficult to obtain a red data list. Table 1 therefore represents a preliminary list only.

Table 1. Preliminary RED DATA LIST of Lichens in Slovenia. – Nomenclature according to POELT (1969), POELT & VĚZDA (1977, 1981) and WIRTH (1980). Classification of endangered species according to TÜRK & WITTMANN (1986, p. 166) modified for Slovenia. – *Symbols* in front of species names *indicate*: *0* = extinct or missing; – *1* = threatened by extinction if pollution is not decreased immediately; – *2* = as 1, but naturally very rare species, or species confined to special habitats; – *3a* = endangered, generally common but showing severe decline in some areas, mainly caused by air pollution; – *3b* = as 3a, but less common, restricted to special habitats where other anthropogenous influences play a significant role; – *r* = very rare in Slovenia or not well known and confined to rare habitats or occurring incidentally; in some cases the actual occurrence in Slovenia is doubtful.

r, 0	*Alectoria ochroleuca*	r, 2	*Parmelia incurva*
3a	*Anaptychia ciliaris*	r, 2	*Parmelia laevigata*
r, 3b	*Bryoria nadvornikiana*	3b	*Parmelia quercina*
3b	*Bryoria subcana*	3a	*Parmelia tiliacea*
3b	*Cetraria sepincola*	3a	*Parmelia pastillifera*
3a	*Cetraria chlorophylla*	r, 1	*Parmelia stuppea*
3a	*Cetraria laureri*	r, 1	*Parmelia taylorensis*
3a	*Cetrelia olivetorum*	r, 3b	*Peltigera aphthosa*
r, 3b	*Cladonia arbuscula*	r, 3b	*Peltigera leucophlebia*
r, 3b	*Cladonia mitis*	r, 3b	*Peltigera collina*
3b	*Cladonia rangiferina*	r, 3b	*Peltigera horizontalis*
2	*Collema fasciculare*	3b	*Peltigera polydactyla*
3a	*Collema nigrescens*	r, 3b	*Pertusaria constricta*
2	*Collema occultatum*	3b	*Pertusaria hemisphaerica*
r, 1	*Evernia divaricata*	3a	*Pertusaria pertusa*
3a	*Evernia prunastri*	3a	*Phlyctis agelaea*
3b	*Icmadophila ericetorum*	3a	*Physcia aipolia*
3b	*Leptogium cyanescens*	3b	*Physcia biziana*
3a	*Leptogium saturninum*	3b	*Physcia hirsuta*
r, 1	*Lobaria amplissima*	3b	*Physcia labrata*
1	*Lobaria pulmonaria*	r, 3b	*Physcia luganensis*
r, 1	*Lobaria scrobiculata*	3a	*Physcia stellaris*
3a	*Menegazzia terebrata*	3b	*Physconia detersa*
3a	*Mycoblastus sanguinarius*	3b	*Physconia enteroxantha*
3b	*Ochrolechia pallescens*	3a	*Physconia grisea*
3b	*Ochrolechia szatalaensis*	3a	*Physconia pulverulenta*
2	*Nephroma bellum*	3a	*Pyrenula laevigata*
r, 2	*Nephroma laevigatum*	3a	*Pyrenula nitida*
r, 2	*Nephroma resupinatum*	3b	*Pyrenula nitidella*
0	*Pannaria rubiginosa*	3a	*Ramalina farinacea*
3a	*Parmelia acetabulum*	3a	*Ramalina fastigiata*
r, 2	*Parmelia arnoldii*	r, 2	*Ramalina fraxinea*
3a	*Parmelia caperata*	2	*Ramalina roesleri*
r, 2	*Parmelia carporrhizans*	r, 1	*Ramalina thrausta*
r, 2	*Parmelia flaventior*	r, 2	*Sphaerophorus globosus*

0	*Sticta fuliginosa*	3b	*Usnea fulvoreagens*
3a	*Thelotrema lepadinum*	3b	*Usnea glabrescens*
r, 0	*Thamnolia vermicularis*	0	*Usnea hirta*
3b	*Usnea barbata s.ampl.*	0	*Usnea longissima*
3b	*Usnea ceratina*	3a	*Usnea subfloridana*
3b	*Usnea florida*		

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Lichen Mapping in Turkey

By Volker John, Bad Dürkheim

With 5 figures

About 100 papers dealing with lichens from Turkey have been published (John 1988). Only a few of them include noteworthy lists of original records. The majority of these papers are monographs in which species recorded before are revised. Furthermore, information on some species has been distributed by means of exsiccata or in data given to the author. A lot of these papers deal exclusively with „manna" (*Aspicilia esculenta* - group). Contributions in Turkish language are of text-book character in most cases, only a few of them present original records.

Thus the published number of Turkish lichen species does not even reach 700. These records can easily be located and may be used in any kind of grid mapping. The first collections, forming the basis of lichenological work, were made at the beginning of this century. Recently lichen collections have been made in areas surrounding points of touristic interest or at roadside localities close to routes connecting historical sites. Those localities of more important collections mentioned in the literature are indicated by triangles in Fig. 1.

While former collections of lichens in Anatolia were made as parts of large interdisciplinary expeditions to the Orient, the recent ones, starting in 1982, were made during special excursions focussing particularly on lichens. Better investigated localities are indicated by circles in Fig. 1. The most comprehensive collection of Turkish lichens may be found in herbarium V. John which will be deposited at POLL (Pfalzmuseum für Naturkunde, Bad Dürkheim). Additional specimens, partly not studied yet, are distributed throughout several herbaria located mainly in Central Europe, including some private ones. However, the number of specimens in collections in Turkey is rather low, although we are trying to deposit at least the duplicates of determined specimens there.

Fig. 2 shows the better investigated areas, at least with respect to species number per grid square (measuring 1° to 1°), as black dotted grids; areas of lower species number, compiled from literature data in most cases, are indicated by black lines. The lichen flora of Turkey will be mapped using a grid following exactly the longitudinal and latitudinal geographic minutes. Two examples of more intensively investigated regions are given in Fig. 3. The data collected will contribute to an inventory of the whole country's species composition. Subsequently these records can be transferred to any kind of grid system.

The application of very low scale monitoring may serve to distinguish polluted areas in urban environments (John 1989). Based both on species distribution data and coverage ratios of crustose, foliose and fruticose lichens as well as on species numbers and lichen vitality, areas of different pollution levels may be discriminated (Fig. 4). This example shows that lichens may successfully be used as bioindicators for air pollution in urban areas in Turkey. Within larger Turkish towns a decline in species number has already become obvious (e. g. Özdemir 1987).

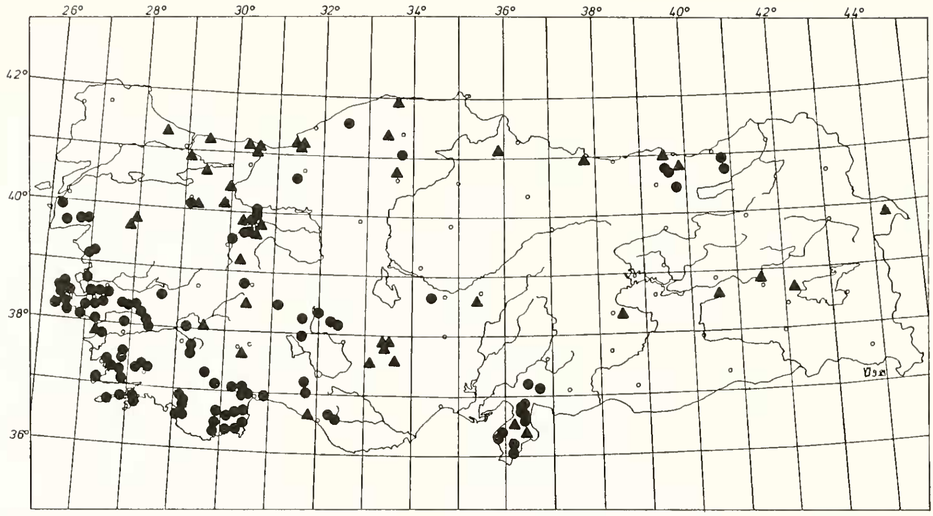


Fig. 1. Survey of collecting localities in Turkey. – *Triangles*: Literature data. *Circles*: collecting sites of the author.

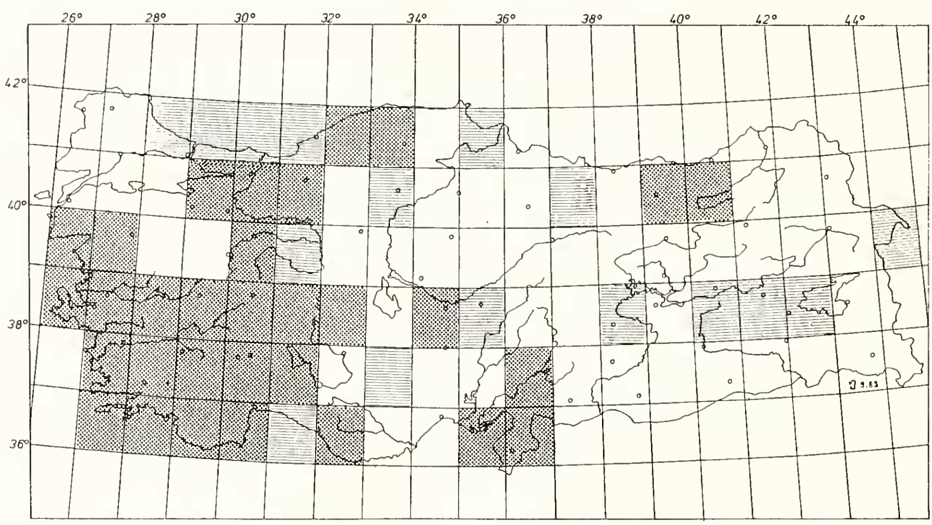
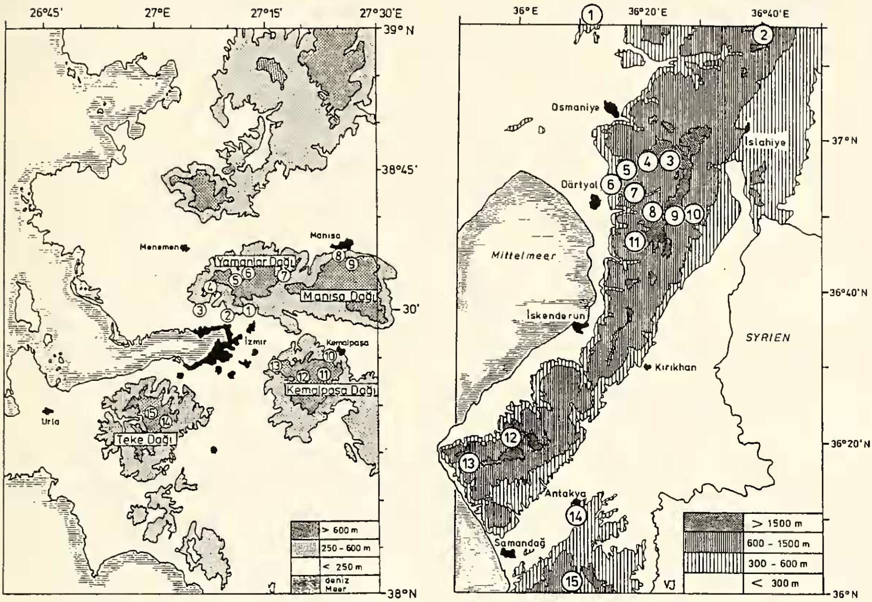


Fig. 2. Investigated areas in Turkey. – *Dotted*: relatively high species number. *Hatched*: relatively low species number.



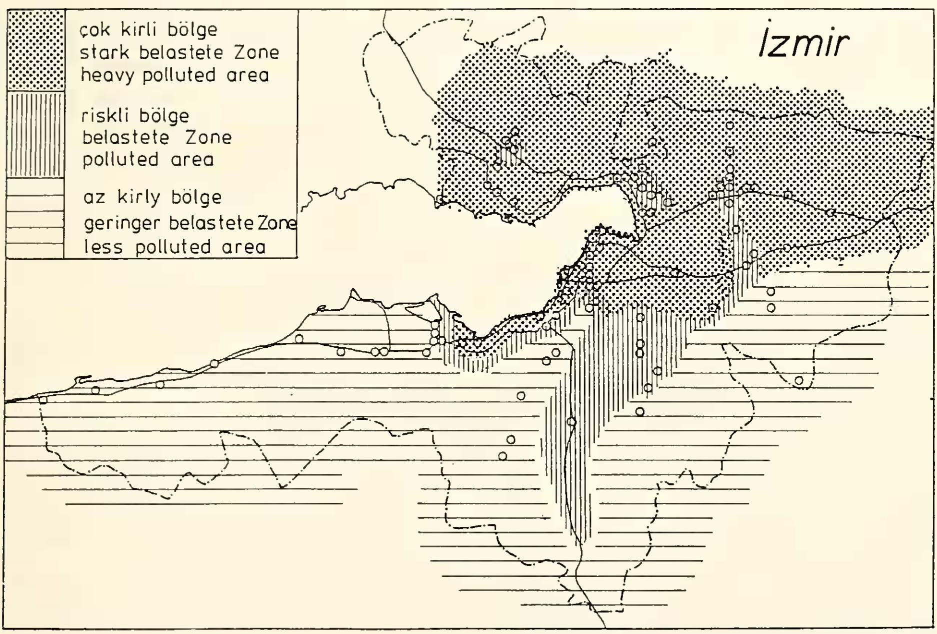


Fig. 3. (above) Two more intensively investigated areas in Turkey. – *Left*: City of Izmir and surrounding mountains. *Right*: Amanos mountains in Prov. Hatay.

Fig. 4. (below) Different lichen zones in the city of Izmir reflecting polluted areas.

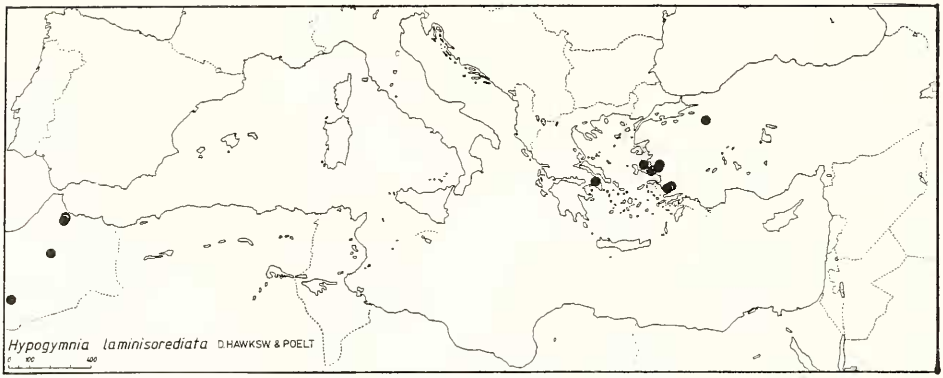


Fig. 5. Distribution of *Hypogymnia laminisorediata* D. Hawksw. & Poelt.

Lichens can also be used for research projects on topics beyond urban ecology. Many species of oceanic distribution face extinction in Central Europe. Several of them can be found no longer in large areas where they recently occurred. It is possible that due to increasing air pollution, use of pesticides, tourism, etc. such species are threatened in Turkey as well. For that reason an inventory of the present situation is extremely urgent.

A survey covering a larger area may of course result in an enlargement of the known distribution areas of certain species (Fig. 5), or in filling gaps on distribution maps. Additional information on the species ecology contribute to a better understanding of the biology of many species as well. *Hypogymnia laminisorediata* (Fig. 5) has only been encountered on bark until recently (HAWKSWORTH 1973). At Manisa Mountain near Izmir, however, this species could also be found on siliceous rock. *Lethariella intricata*, which usually occurs on siliceous rock (KROG 1976), was recorded on bark at Besparmak Mountain near Milas. In this case the species becomes a valuable indicator of old forests (SÉRUSIAUX 1988). An extraordinarily large number of lichen species, known to fruit rarely, has often been recorded with apothecia developed on many thalli. Results of research on Turkish lichens are also of general scientific interest. Numerous species may be new to science. Even from the mountains surrounding Izmir six new species were described from a total of 250 taxa, and at least 75% of them were new records for Turkey.

Further emphasis in Turkish research is given to lichen chemistry (e. g. HUNECK & JOHN 1987). New chemical strains as well as new lichen substances have been detected. Accumulation of the radioactive fallout of ^{137}Cs following the Tchernobyl disaster was found in several lichen species, showing different levels in different regions in Anatolia.

Although it is a relatively pure scientific undertaking, analysis of lichen distribution becomes a commercial and political problem as soon as the question of financial support of special research projects appears. This problem is less severe in some countries which regard nature and environment protection as necessary. In a geographical sense only part of Turkey, i. e. Thrakia, belongs to Europe. The state itself, however, is a member of the Council of Europe and associated to the European Community. Possibly it will only be a matter of time for Turkey to become a full member of the EC. It will be necessary then to pay attention to Turkish lichens in an equal manner, e. g. to compile a Red Data Book on lichens, revising the one pu-

blished by SÉRUSIAUX (1988) for the present EC members. Already VITIKAINEN (1987) has included records from Turkey in his distribution maps (50 km × 50 km UTM grid) of *Peltigera* in Europe.

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2. Data Storage and Analysis by Computer

Floristic and faunistic Databases on Personal Computers

By Paul Diederich, Luxembourg

With 4 figures

1. Insufficiencies of a distribution atlas – necessity of a database

A distribution map gives inaccurate and incomplete data; a database is necessary to know the precise location, date, ecology, references, etc. Furthermore it is difficult to correct errors on a distribution map without knowing the precise references. Finally a database allows a lot of other applications.

2. Mainframe versus personal computer

The following table gives the main characteristics of, and differences between, mainframes and personal computers. Both systems are nowadays very quick and offer sufficient memory capacities for large floristic and faunistic databases containing more than 10 million data. The success of personal computers may be derived from their easy accessibility, especially for amateur scientists. They have the disadvantage that simultaneous use of the same database on several computers leads to coding difficulties.

	Mainframe	Personal computer
Accessibility	Easy for institutions, difficult or impossible for private scientists	Easy access for institutions, private scientists and amateurs
Memory capacity	Sufficient for every database	Sufficient for more than 10 million records (on one hard disk or optical disk)
Speed	Generally high, but repeated access to memory by telephone line or simultaneous activity on many terminals may slow down the speed	Generally high, but access to disk is slow. Good database programs using indexes can be very fast
User comfort	Bad	Generally good (e. g. graphic possibilities)
Use by several persons	Easy	Coding difficulties

3. Coding difficulties on personal computers

3.1. Difficulties

On mainframe computers several users work with the same database. If, for instance, a new name of a taxon is introduced in the database, this name will be accessible to every user.

On personal computers, however, there are as many physically different and separated databases as users, working each on his own PC. By adding a new taxon to the database, each user must use the same code for the same species. There is the risk that two users will assign the same code to several different taxa, or that two users will assign different codes to the same taxon. The same problem arises with the coding of publications, observers, etc. From time to time all the data introduced into the different private systems must be merged to form the complete database.

3.2. Solutions

Method 1

One rapid PC with a large memory capacity functions as a server, i. e. it is linked by modem to a telephone line, and every user uses his PC as a terminal.

Result: only 1 database, as with a mainframe.

Method 2

To begin with, rather a complete list of taxa, publications, etc. should be available. If new taxa or publications must be added, one person should be responsible for the attribution of new codes. To code publications, a particular coded list is established for each country, and for each group of organisms: one supervisor is needed for every country.

For practical reasons, it must be accepted that persons from different countries use different programs and a different database structure lacking any compatibility. The flux of data between several countries can then be achieved by sending printed listings by post (e. g. list of the existing European specimens of one species; list of UTM squares concerning one species) or by transmitting a subset of data understandable by every database (containing for instance the country, locality, UTM square, date and species) by telephone line or on a floppy disk.

Merging different databases

Once a year the supervisor of the database receives the new data from other users (on a floppy disk or by a telephone line) and merges them with the existing data. Each user can get the complete database afterwards.

4. Coding of taxa

4.1. Different ways of coding taxa

In databases on mainframe computers it may be conceivable and even useful that a proper code is automatically assigned to each of the different epithets, and that the synonymies are added by a specialist later on.

On PCs, however, an almost complete list of epithets must be available to begin with, and only one supervisor is allowed to add further taxa or synonyms.

To add data to the database, a special interface may allow the user to designate the species by their full name, an abbreviation or a code. If we want a comfortable and easy management of the data, the machine should, however, internally use a suitable code for dealing with problems like synonymy or hierarchy of taxa. Three different coding methods are often used:

(a) Abbreviation

E. g. RamFar — *Ramalina farinacea*

Disadvantages: Instability of nomenclature.
Taxonomical changes.
Identical abbreviation for 2 taxa.
Different abbreviations for 1 taxon.

(b) Hierarchical coding

E. g. 003.02.2 *Amanita citrina* var. *citrina* (cf. Standaardlijst van Nederlandse Macrofungi; 003 denotes the genus, 02 the species, and 2 the variety).

Disadvantages: Taxonomical changes.

(c) Numerical coding

E. g. 1410 *Thelotrema lepadinum* (cf. British list for lichen mapping).
Disadvantages: None.

4.2. Principles of numerical coding of taxa

(a) A numerical rank is attributed to every taxonomical rank

E. g.:

4	Regnum	75	Species s.l.
12	Division	76	Species
20	Class	77	Species s.s.
28	Order	78	
36	Family	79	Subspecies s.l.
44	Tribe	80	Subspecies
52	Genus	81	Subspecies s.s.
60	Section		
68	Series		
76	Species		
84	Variety		
92	Form		

(b) Taxa of different ranks are coded in the same way

Code	Taxon	Rank
1407	Graphidales	28
1408	Thelotremataceae	36
1409	*Thelotrema*	52
1410	*Thelotrema lepadinum*	76
1411	*Thelotrema monosporum*	76
0795	*Lecidella elaeochroma* s.l. (incl. *L. achristotera*)	75
0796	*Lecidella elaeochroma* s.s. (excl. *L. achristotera*)	77
0797	*Lecidella elaeochroma* var. *elaeochroma*	84
0798	*Lecidella elaeochroma* var. *soralifera*	84

(c) Taxonomical synonyms must have different codes

Code	Taxon	Rank	Synonym
1234	*Ramalina farinacea*	76	−1237
1237	*Ramalina reagens*	76	1241
1241	*Ramalina subfarinacea*	76	1234

If one author considers that *Ramalina farinacea, R. reagens* and *R. subfarinacea* are synonyms, he will nevertheless code epiphytic continental specimens as 1234 *R. farinacea*, and saxicolous maritime specimens as 1241 *R. subfarinacea*. If these taxa are treated as different species later on, no information will be lost.

In the chart above, each taxon points to the synonym following, and the last synonym points to the first one. The currently used epithet is marked by a minus sign.

Note: Nomenclatural synonyms may have the same code.

(d) Coding of the hierarchy using 2 links

Code	Taxon	Rank	Syn	Link1	Link2
0300	Gen1	52		0301	
0301	Sp1	76			0302
0302	Sp2	76		0304	0303
0303	Sp3	76			0300
0304	Sp2Var1	84			0305
0305	Sp2Var2	84			0302

Each taxon points to the first taxon of a lower rank through Link1. Link2 points to the taxon, following, of the same rank, or, if no taxon of the same rank remains, to the taxon of a higher rank (Fig. 1).

5. Coding of doubtful or inaccurate data

5.1. Doubtful determination

Thelotrema sp. is coded as
1409 *Thelotrema*
Thelotrema cf. *lepadinum* is coded as
1410 *Thelotrema lepadinum*
and the record will be marked as doubtful.

5.2. Inaccurate date

Different possibilities:

27. 9. 1929
9. 1929
1929
about 1929
1929 ± 4
1925 – 1933

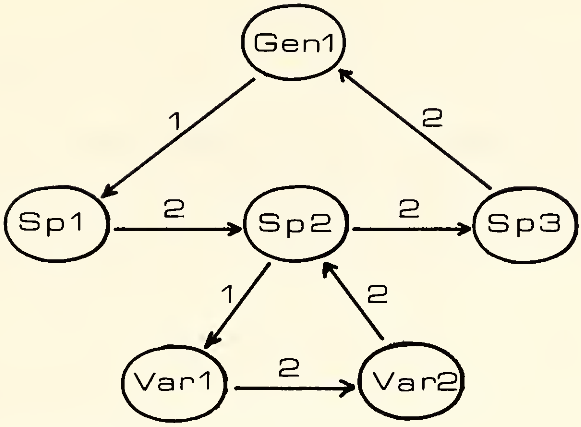


Fig. 1. Coding of the hierarchy using two links, 1 and 2.

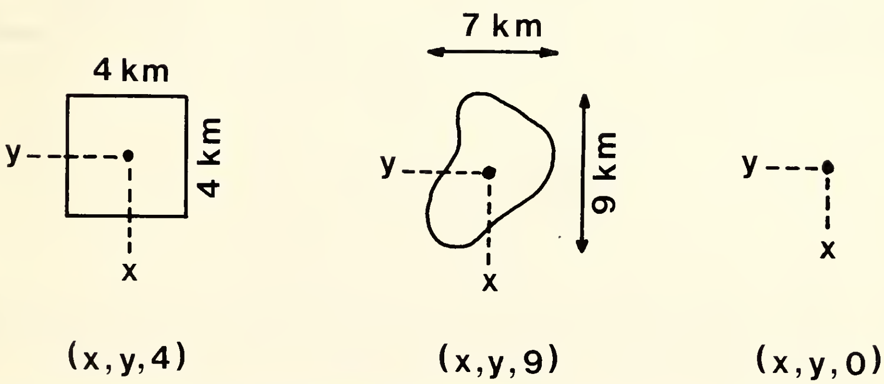
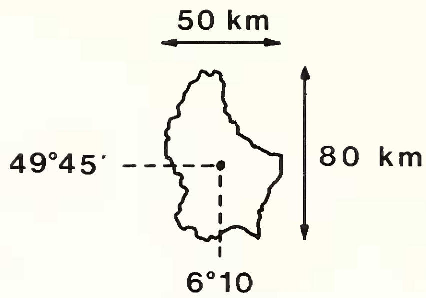


Fig. 2. Coordinates (x, y, d) in three different situations.

5.3. Inaccurate location

The localities are easily coded using geographical coordinates expressed either in a „natural“ system (e. g. longitude – latitude) or in an „artificial“ (national or international) grid system (e. g. UTM, MTB in Germany, IFBL in Belgium and Luxembourg, etc.). Many locations given by authors of the 19th century are inaccurate, and a correct designation in any system of (x, y) coordinates is difficult or even impossible. For treating these data by computer in an efficient way (without loss of information), coordinates (x, y, d), where (x, y) represents the centre of the studied area, and d represents the diameter of the same area should be used. Three different situations may occur, either squares (or rectangles), areas of an arbitrary shape or a precise location. The diameter (in km) is chosen as the largest among the vertical and horizontal dimension of the given area (Fig. 2).

The inaccurate location „Luxembourg“ (precise locality unknown) (Fig. 3) will be coded as (6°10′, 49°45′, 80).



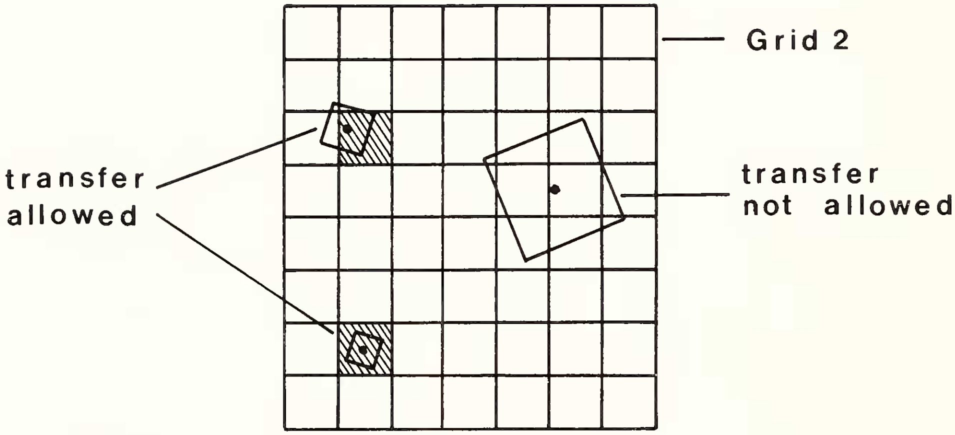


Fig. 3. (above) Coding of the inaccurate location „Luxembourg".
Fig. 4. (below) Transfer of data from grid system 1 (three different squares) to grid system 2. The transfer is allowed for the two small squares, but it is not allowed for the large square whose diameter is larger than the diameter of the squares of grid 2.

6. Compatibility of different mapping systems

6.1. Principles

(a) A distribution map need not necessarily contain precise data (which can be found in the database).

(b) Errors occurring on a distribution map must be rare (e. g. less than 25% of the data) and small (e. g. less than 30% of the diameter of the squares).

6.2. Method

The transfer of data from a square S1 (x1, y1, d1) to a square S2 (x2, y2, d2) is allowed if:
(a) the centre (x1, y1) is situated in the square S2;
(b) d1 ≤ d2.

Otherwise the transfer is not allowed, and data of system 1 cannot be used for a distribution map in system 2 (Fig. 4).

7. Applications of a database

(a) Atlas of distribution maps.

(b) List of species (from a locality, from a country [checklist], from a period, growing on *Quercus*, etc.).

(c) Data on one species (concerning herbarium material, literature reports, field observations; investigations about the ecology, frequency, etc.).

(d) Complex requests (e. g. find a list of all the localities where *Lecanora argentata* or *L. carpinea* was found in the 19th century on *Fagus*, and where none was found after 1980).

(e) Prepare reports to be included in a manuscript by a word processor (e. g. a list of the specimens of one species; a list of the species from one locality).

(f) Herbarium management.

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Numerical Analysis of Data on Lichen Distribution in Baden-Württemberg: a Preliminary Outline

By Martin Pietschmann, Stuttgart

With 4 figures

Summary

"Numerical techniques" used to discern putative causalities in lichen distributional patterns in Baden-Württemberg (Southwestern Germany) are outlined in a manner understandable by non-specialists. They present current interactions occurring between organisms and environmental factors in graphic displays. Examples are given for two phenomena: species redundancy and dimensionality of the structure of lichen vegetation. Both examples are major branches within the strategy of applying the "zero-hypothesis", the assumption that there is no distributional pattern at all, in the analysis of large scale distribution data. Future results are expected to yield new aspects for sampling design, which may then better fit the microclimate dependent ecology of cryptogams.

Zusammenfassung

„Numerische Techniken" in der Analyse der Flechtenverbreitung in Baden-Württemberg (Südwestdeutschland) werden als ein Hilfsmittel vorgestellt, mit dem die Ursachen der Flechtenareale beschrieben und in verständlicher Form auch dem Nicht-Spezialisten vermittelt werden können. Mit ihrer Hilfe können existierende Wechselwirkungen zwischen den vorkommenden Organismen und Faktorennetzen graphisch dargestellt werden. Für die beiden Phänomene der Artenredundanz und der strukturellen Dimensionalität der Flechtenvegetation werden Beispiele aufgeführt. Beide Beispiele stellen Hauptwege einer Strategie dar, welche die folgende Nullhypothese anwendet: Das großräumige Vorkommen von Flechten weist keine wahrnehmbaren Verbreitungsmuster auf. Die zu erwartenden Ergebnisse können unter Umständen neue Wege zu einer verbesserten Aufnahmetechnik weisen, die der Ökologie von Kryptogamen besser gerecht werden kann.

1. Introduction

In modern times all sciences are charaterized by a vast increase in data and knowledge. When I started school about 25 years ago, no lichen floras of Central Europe existed, whereas nowadays I am lucky to find these as well as explicit data on lichen distribution, e. g. in Baden-Württemberg (Wirth 1987). But I would like to ask what the aims – beyond distributional aspects – are of drawing maps which look far too rough to be able to compete with detailed low-scale recording of distribution.

I think, everybody knows from his own personal field experience that lichens in general are strikingly sensitive organisms which can indicate what is occurring in the surrounding environment.

Yet, how can one mediate between the lichen specialist and the laymen, who by looking at maps and pictures may hardly be able to imagine what an immense degree of information was lost, if lichens would disappear?

One promising possibility might be to inform laymen that „patterns and processes" evident in lichen vegetation reveal intrinsic networks between the natural landscape and the living organisms. This approach implies the use of an explicit and

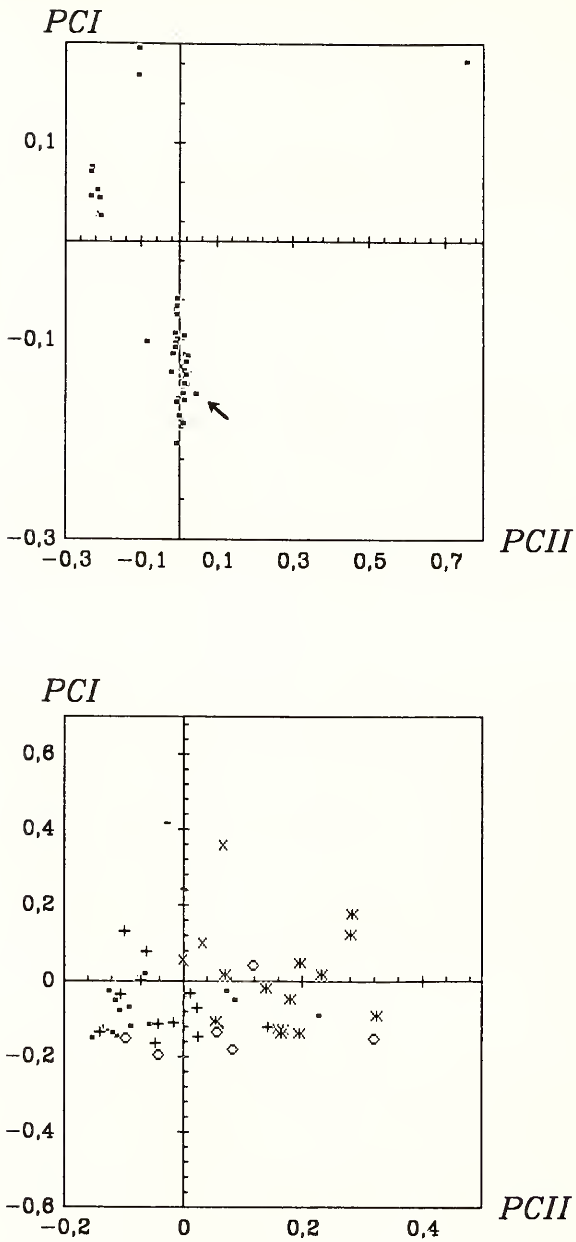


Fig. 1. PCA-ordination scatter diagrams performed on large scale and low scale data. Results of any analysis obviously depend on scale. The diagram above indicates strongly discontinous data of fairly simple structure. The one below shows results of an ordination of the point cluster indicated by an arrow in the upper diagram. Overlay symbols indicate compositional structure of high dimensionality not visible in two-dimensional space.

consistent medium or language, which must be capable of filling the hiatus between the specialist and the non-specialist. What I have in my mind for this task of course is the abstract but condensed and powerful language of "numerical techniques".

I will try to describe one major problem, that may perhaps be of special importance for the evaluation of lichen distribution data: Can we expect highly structured lichen area-types to exist, when it is known that lichens are cryptogams sensitive to microclimate?

First let me state simple hypotheses on what is happening, based on data from 318 map grids and about 1000 lichen species in Baden-Württemberg: Is there a random or a well structured distribution? Are there major ecological factors which are of a high explanatory value or not?

Fig. 1 shows two fairly different scatter diagrams. The upper ordination scatter diagram shows two well separated point clusters and four obvious outlayers. The one below is a principal component analysis of the point cluster indicated above by an arrow.

I do not want to give detailed descriptions of the main strategy, the way to manage such a great mass of data and the possibilities of interpreting subsequent numerically derived results. What I am going to discuss are two major branches within my strategy of analysing these data.

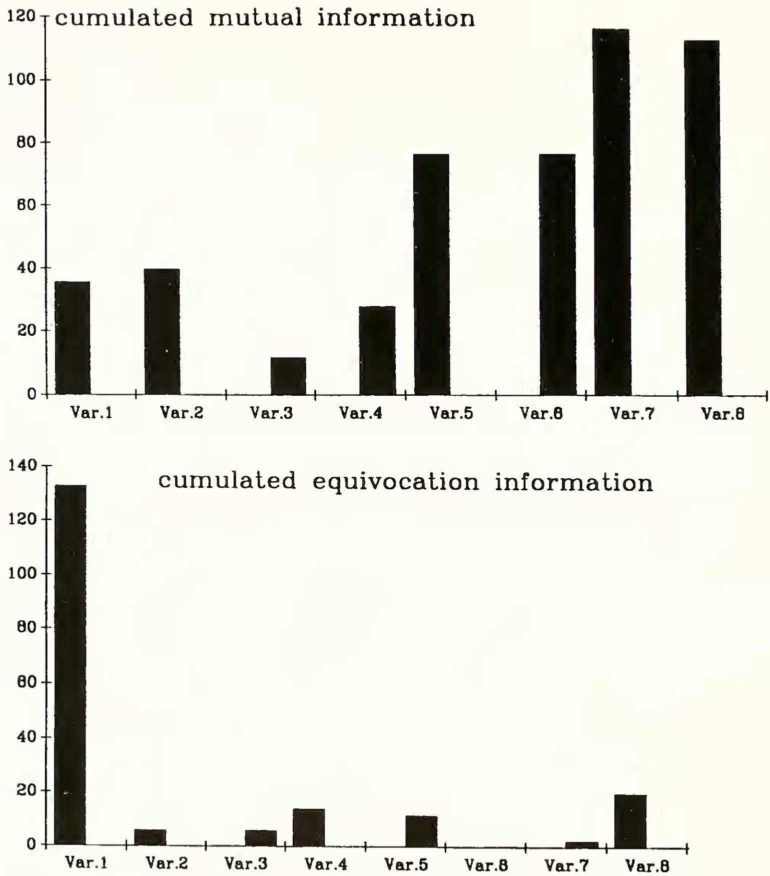
2. Species redundancy

It is well known that different species may have a similar distribution because of affinities in their ecological demands. Thus, it is possible to reduce a long species list by a criterion of redundancy (Feoli et al. 1984). Figure 2 shows results achieved by applying two different information redundancy criteria to the same data set, the mutual information I (Au; Az) and the equivocation information E (Au; Az). Both diagrams describe the same data set, but the results look rather different. The first describes the mutual enclosement of two frequency distribution sets of variables, the so called "intersection of information". The latter describes the unique part of two frequency distributions, i. e. that part of information which is not influenced by other variables. Ranking by equivocation information indicates a strong asymmetry of information present in the variables considered.

Figure 3 shows the well known VENN diagram which symbolizes the relation between the two redundancy criteria. The degree of overlapping information (mutual information) depends on the individual types of information I (Au) and I (Az). The total uncertainty [joint information I (Au; Az)] also depends on the degree of intersection of the frequency distribution. How can the relation of these two redundancy criteria to lichen distribution data be described?

Assuming a general influence of man's activities, e. g. SO_2-emission, there should exist a large group of species, let us say around *Hypogymnia physodes*, which is favoured by the general decline of natural woodland species because they are able to colonize stands where lichens grow poorly. This is the part of intersection of information which corresponds to the absence of species indicating high air quality, e. g. the group around *Lobaria pulmonaria*.

On the other hand, there may exist rare assembleges of species which do not correlate with air quality factors but represent suppressed patterns depending on the intactness of natural environments which are clearly underrepresented in a man influenced world. Due to its uniqueness such an assemblage provides very specific



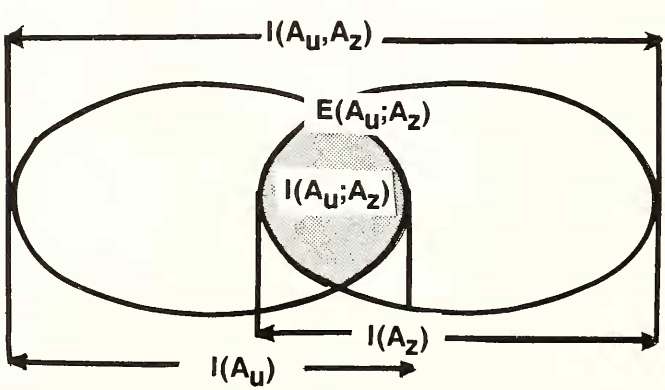


Fig. 2. (above) Bar diagrams of two different redundancy criteria applied to the same data set.

Fig. 3. (below) VENNs diagram describing relations between different functions of information.

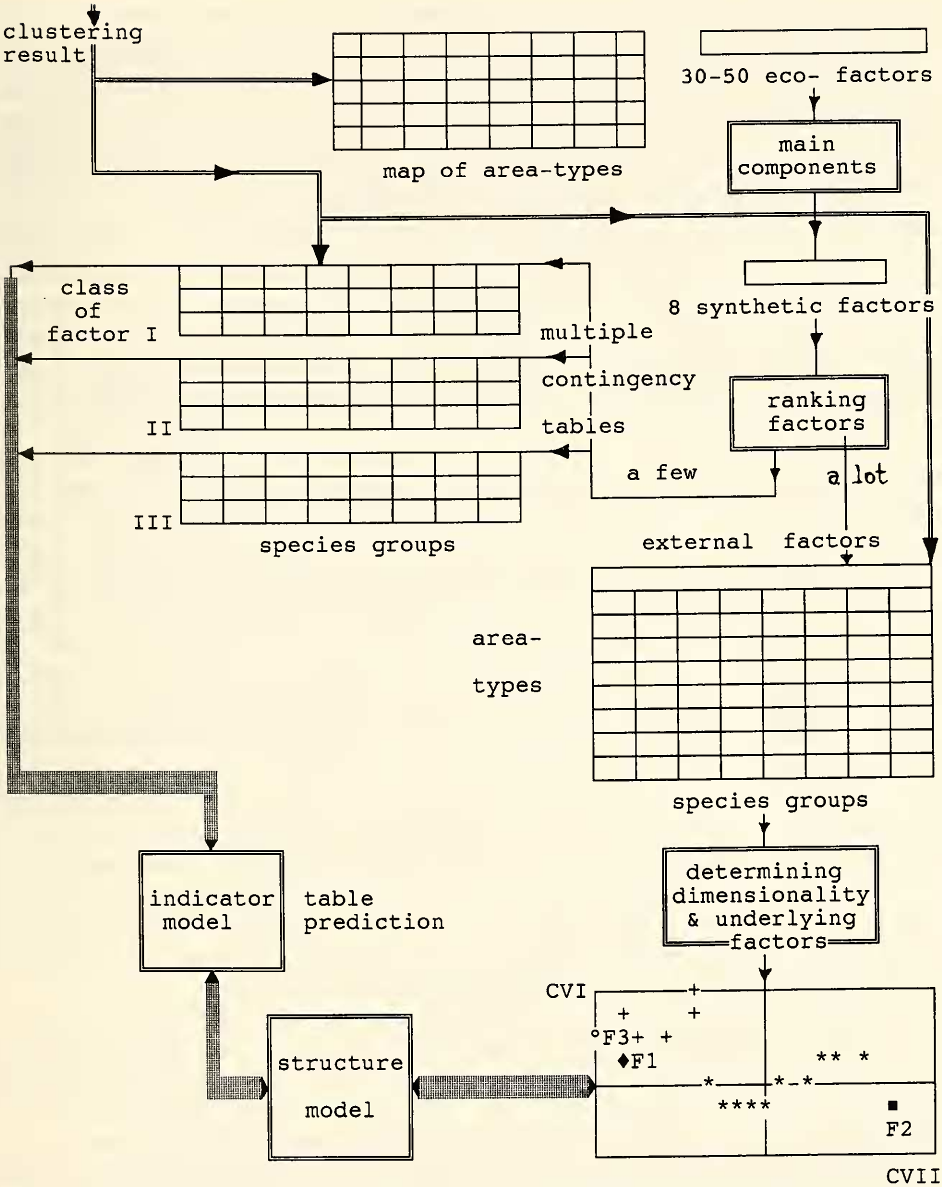


Fig. 4. Flow chart of the ultimate step of numerical analysis. At the top information enters resulting from preliminary clustering of species versus map grids. The major dichotomy of simple to complex variation pattern is shown in the center.

information, which is only partially dependent on major environmental trends. The environmental biologist is clearly asked in this case to give a sound answer to which of the two redundancy criteria is preferred in order to reduce a long species list without loss of considerable information.

3. The underlying structure of ecological factors

It seems impossible to derive a priori decisions about continuity and discontinuity of ecological factors determining structure of distribution, the so called "dimensionality of structure" (Feoli & Orloci 1979), from the considered data set (318 map grids and about 1000 lichen species). It is more instructive to analyze factors and species simultaneously, which alone is the ecologically proper approach, than to factors and species jointly as performed by Haeupler (1974).

If area-types and species groups are identified by clustering criteria a simple question arises, which yet may be difficult to answer. Are assignments like these satisfactory?: „A species group is the representative of a given area-type." On the contrary, I think we should demand stability of classificatory results (area types and species groups) and ask in the sequel, what makes lichen vegetation show the revealed distribution patterns. In doing this, we will start to analyse factor/species groups contingencies.

Different strategies are proposed depending on whether vegetation structure shows clear trends or a seemingly chaotic, inobvious variation in composition. Figure 4 shows a flow chart of the whole process. Here again, analysis of c. 30 different ecological factors which are expected to show interesting interactions with lichen distribution, is another difficult task. For instance, before starting the analysis, we have to sort out logical and partially logical factor to factor dependencies (Green 1979). For example there may exist a large scale-dependency between elevation and annual precipitation in Baden-Württemberg. This is why any statistical analysis of factor interactions and factor/species interactions is going to fail, simply because of the assumption of an independency of variables. I will therefore analyse ecological factors in the sequel by extracting independent synthetic principal component (PC) axes which are capable of summarizing the structure of factors in a fairly powerful way. Within this step success of extracting PC-axes can be estimated and it can be decided, if it is possible to disregard a large number of extracted variables.

If the number of important axes is low, unidimensional factor/species group-contingency tables are sufficient to deduce an indicator-model of maximum simplicity (Daget et al. 1972). This classification by single factors can of course be displayed graphically by ordination scatter diagrams or grid map overlays.

If the number of important axes is high, the dimensionality of species concentrations versus area types has to be analysed in order to build up a structural model of lichen vegetation in Baden-Württemberg. Applied to both cases, the zero-hypothesis is stated as: "There is no structure at all." (Orloci & Kenkel 1985). Inference of mans influence can be stated indirectly by the dimensionality of vegetation.

In both cases structured tables, similar to those used in phytosociology, will be used. The deviation from random variation can be calculated from these tables.

4. Conclusions

Both discussed approaches are intended to yield comprehensive tabular and graphical representation of results. Thus, the results themselves can serve as an efficient and convincing medium by using a language which everybody is able to read, i. e. graphics.

I anticipate results which can serve as a baseline for estimating the efficiency of our sampling design. For instance, deleting species abundancy can be a matter of argument. On the other hand, is it worthwhile to map each of the c. 1000 lichen species to

gain conclusions about large scale variation patterns, e. g. of environmental stress? Or, is it sufficient to confine the sampling procedure to a set of indicator species? Our tentative predictive model can help in solving important questions like these.

Planning of mapping projects in the future can be infered indirectly from results obtained in Baden-Württemberg. Thus this pilot project can be a step forward towards an integration of lichenological knowledge into plans of nature protection and other mapping projects carried out by higher plants specialists or zoologists. New bridges could be built if we are able to state results explicitly from a sound data base.

5. Literature

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Stuttgarter Beitr. Naturk.	Ser. A	Nr. 456	147–148	Stuttgart, 31. 12. 1990

Part II: Proposals and Agreements

Initiation of a European Lichen Mapping Project — Proposals and Considerations

By Volkmar Wirth, Stuttgart

It is highly desirable to achieve a more precise description of the actual distribution of lichen species in Europe. We have to estimate the cost of obtaining that knowledge and decide which efforts must be undertaken to achieve it. We need to develop an organization and choose appropriate methods.

The following points involve some ideas, thoughts or proposals which may serve as a base-line to start this discussion.

(1.) Mapping should be a grid mapping scheme because it provides an economical way to acquire data and to process the data by computer. As a European grid system is already well established for several botanical (higher plants, mosses) and zoological mapping projects — namely the UTM-grid system — this system should be used in lichenology as well. A further economical and practical advantage is the availability of a printed map scheme (Flora Europaea Project, Jalas & Suominen 1972).

(2.) Time is precious for us all. It is very important to ensure that joint projects do not become too heavy a burden on us. It would be ideal if the resulting European maps were a byproduct of the national projects which are fundamental for mapping in Europe.

(3.) The most convenient way to achieve this is based on well organized, computer-sustained national mapping projects using grids which can be transcribed or incorporated into the larger grid of a European mapping scheme. This transcription can be performed by computer, at least to a certain extent. If there is no computer assistance available manual transcription is feasible by placing a transparent overlay with the European grid on it over the national maps.

(4.) As the knowledge of the distribution of a lichen species is the sum of information compiled by many lichenologists in several countries, European mapping cannot be a single scientist's job. Indeed, it is absurd to imagine that a single worker or a group of persons would be able to collect the data alone. Neither can the European project be organized by a single head scientist at the top, compiling and publishing data delivered to him by many others. Those lichenologists working intensively on European maps should jointly participate in editing them.

(5.) There surely are several possibilities to satisfy these conditions. One way could be to apportion different species among different lichenologists interested in these species and to start mapping with well known species or those of delimited distribution. This method is the one applied by the European bryologists (Schumacker 1982, 1984, 1985).

Of course it would not be economical if the editors of the map of a certain species would have to identify the correct grid unit of records for the whole of Europe. It would be more reasonable to exchange UTM-data among the co-workers from diffe-

rent countries, each of them delivering (processed) data of his region. Additionally the map editor should also inform the national mappers on the state of his knowledge on the distribution of the respective species.
The subsequent publication of single maps or collections of maps may then be done by one author or better by a group of authors involved in the work. A more comprehensive edition could be achieved later by assembling already published maps and updating them.

(6.) A current list of treated species and lichenologists dealing with them should be published. Negative aspects of hierarchical organization would be minimized in this way and it would be as fair as possible to the interests of individual scientists.

(7.) Prerequisite to this procedure is a general methodological agreement concerning:

7.1. the type of grid;
7.2. the basic map scheme for publication; all countries should use the same basic map type;
7.3. the differentiation of records into historical periods;
7.4. any other differentiation of symbols used in the maps;
7.5. a list of species to be mapped in the future;
7.6. the use of computer programs.

(8.) We should discuss the need for financial support concerning the European lichen mapping project and to whom we might address our requests.

(9.) A checklist of European lichen species as a synthesis of different national lists should be established. It might even be a very provisional list. In fact, we have no real imagination about the exact number of species present in Europe, and such a list may be a base-line. Recently the OPTIMA Congress decided to establish such a list for the Mediterranean countries. Lichenologists involved were Nimis, Roux and Llimona. It may be more difficult to find an agreement at a European scale, but it should be tried anyway.

Literature

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Meeting on Lichen Mapping in Europe – Agreements and further Proposals

By Roland Moberg, Uppsala and Volkmar Wirth, Stuttgart

With 1 table

Agreement on the following proposals was achieved during the discussion among the participants of the meeting.

(1.) Mapping will be performed as a grid mapping using the well established UTM-grid system (50 km × 50 km grids). This system is widely used in floristic and faunistic mapping projects. Map schemes for the presentation of lichen distribution are easily available from the Flora Europaea Secretariat (Helsinki). There was no general agreement concerning the integration of the Canary Islands and Turkey.

(2.) It is recommended to start mapping primarily with endangered species.

(3.) Compilation of distribution data for single species and edition of the corresponding distribution maps will be performed by individual lichenologists.

(4.) The species to be mapped will be selected in consultation with the mapping secretariat. Every participating country was asked to select three species (+ two substitutes) to be mapped for a pilot project. Meanwhile, the secretariat has finally coordinated species and editors (Table 1).

(5.) To faciliate mapping, an exchange of mapping data between the national representatives and the map editors is recommended. This implies a transfer of already existing data as UTM-grid reference to the editor and, if necessary, a help in identification of the respective UTM-grid for unidentified localities.

Table 1. Lichens selected for mapping (revised at the Regensburg meeting on 31. 08. 1990).

Austria: *Alectoria nigricans, Dactylina ramulosa*
Czechoslovakia: *Anaptychia ciliaris, Parmelia caperata*
Denmark: *Cetraria sepincola, Lobaria laetevirens*
Finland: *Heterodermia speciosa, Ramalina roesleri*
France: *Parmotrema arnoldii, Teloschistes chrysophthalmus*
Germany, GDR: *Baeomyces placophyllus, Umbilicaria polyrrhiza*
Germany, FRG: *Collema fluviatile, Lobaria amplissima*
Great Britain and Ireland: *Anaptychia runcinata, Thelotrema lepadinum*
Hungary: *Cladonia magyarica, Solorinella asteriscus*
Iceland: *Nephroma arcticum, Umbilicaria proboscidea*
Italy: *Parmelia soredians, Umbilicaria torrefacta*
Luxembourg: *Enterographa crassa, Lecanactis abietina*
Netherlands: *Normandina pulchella, Parmelia acetabulum*
Norway: *Anema decipiens, Lecanactis latebrarum*
Poland: *Calicium adspersum, Pertusaria hemisphaerica*
Romania: *Gyalecta jenensis, Synalissa symphorea*
Spain: *Acarospora hilaris, Peltula euploca*
Sweden: *Collema curtisporum, Leptogium rivulare*
Switzerland: *Lobaria scrobiculata, Usnea ceratina*
USSR: *Letharia vulpina, Menegazzia terebrata*
Yugoslavia: *Lobaria pulmonaria, Ramalina fastigiata*

(6.) It is recommended to differentiate between records made until 1975 and 1976 onwards.

(7.) A request for financial support, e. g. from the EC, will be made after initial results have been obtained.

(8.) R. MOBERG and V. WIRTH were elected as Secretaries of the Subcommittee of the International Association of Lichenology named „Mapping of Lichens in Europe", and will work until the Fourth International Mycological Congress, Regensburg 1990.

(9.) The following lichenologists were nominated as responsible representatives of the various countries.

Austria:	R. TÜRK
Belgium:	E. SÉRUSIAUX
Czechoslovakia:	I. PIŠÚT
Denmark:	U. SØCHTING
Finland:	O. VITIKAINEN
France:	C. VAN HALUWYN
Germany:	V. WIRTH (FRG)
	R. STORDEUR (GDR)
Great Britain and Ireland:	M. SEAWARD
Hungary:	E. FARKAS
Iceland:	H. KRISTINSSON
Italy:	M. TRETIACH
Luxembourg:	P. DIEDERICH
Netherlands:	H. VAN DOBBEN
Norway:	T. TONSBERG
Poland:	W. FAŁTYNOWICZ
Spain:	A. GOMEZ-BOLEA
Sweden:	R. MOBERG
Switzerland:	C. SCHEIDEGGER
USSR:	H. TRASS
Yugoslavia:	F. BATIČ.

The secretaries propose that a list of all European lichens shall be compiled by a synthesis of national checklists, whether published or not, in the near future. Despite many deficiencies and errors this list could give an important initial idea of the total species number of the European lichen flora.

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Part III: Regional Lichen Mapping Projects in Germany
Regionale Flechtenkartierungen in Deutschland

Übersicht

Kartierungsprojekte im Meßtischblattraster in der Bundesrepublik Deutschland. Literaturverweise siehe WIRTH, in diesem Band, S. 93.
(Grid mapping projects in Germany. Literature citations see WIRTH, this vol.).

Baden-Württemberg*):
Umfassende Kartierung abgeschlossen (WIRTH 1987). Ergänzungen in Bearbeitung.

Bayern:
Kein umfassendes Kartierungsprojekt. Nur kleinere Gebiete in fortgeschrittenem Stadium: Teile von Unterfranken (WIRTH), einzelne Grundfelder in Mittel- und Oberfranken (KILIAS, WIRTH), einzelne Grundfelder im Bayerisch-Böhmischen Wald (WIRTH), einzelne Grundfelder im Alpenvorland (FEUERER), Berchtesgadener Land (TÜRK & WITTMANN 1987). Nur Epiphyten: Unter- und Mittelfranken (RITSCHEL 1977).

Berlin:
Kartierung in fortgeschrittenem Stadium (mehrere Arbeiten von LEUCKERT und Mitarbeitern, POELT, SEAWARD u. a.).

Bremen:
Erfassung von Epiphyten (SCHNEIDER 1985).

Hamburg:
Kartierung im Gang (FEUERER, in diesem Band).

Hessen:
Kein umfassendes Kartierungsprojekt. Geplant: Taunus (SCHÖLLER); in fortgeschrittenem Stadium: Odenwald (WIRTH), Einzelfelder in der Rhön (WIRTH), Meißner und Umgebung (KÜMMERLING 1990).

Niedersachsen:
Kein umfassendes Kartierungsprojekt. Extensive Kartierung des nordwestlichen Landesteils im Gang (LINDERS). Kartierung des Kreises Harburg in fortgeschr. Stadium (ERNST et al. 1990). Nur Epiphyten: Lüneburger Heide (SCHNEIDER 1985) und Landkreis Hildesheim (LINDERS).

Nordrhein-Westfalen:
Kein umfassendes Kartierungsprojekt, doch Kartierung in Westfalen auf Basis privater Initiative (WOELM & Mitarbeiter, vgl. GROOTEN & WOELM 1986). – Kartierung der höheren Flechten der Eifel im Gang (SCHLECHTER).

Rheinland-Pfalz*):
Umfassende Kartierung in 1. Phase abgeschlossen (JOHN 1990; vgl. JOHN 1987).

*) Von den Ländern finanzierte oder unterstützte Projekte. – With financial support by government.

Saarland:

Umfassende Kartierung abgeschlossen, vor Publikation (John 1990; vgl. John 1986).

Schleswig-Holstein*):

Umfassendes Kartierungsprojekt abgeschlossen, vor Publikation (Jacobsen).

Über Flechtenkartierungen im Gebiet der seit dem 3. 10. 1990 zur Bundesrepublik Deutschland gehörenden neuen Bundesländer Brandenburg, Mecklenburg-Vorpommern, Sachsen, Sachsen-Anhalt und Thüringen informiert der Beitrag von Stordeur in diesem Band.

Stuttgarter Beitr. Naturk.	Ser. A	Nr. 456	153–159	Stuttgart, 31. 12. 1990

Ziele und Methoden der Kartierung von Flechten in Schleswig-Holstein

Von Peter Jacobsen, Kiel

Mit 3 Abbildungen und 1 Tabelle

Zusammenfassung

Die derzeit laufenden Untersuchungen zur Erfassung und Charakterisierung der Flechtenflora Schleswig-Holsteins werden erläutert. DISMAP, ein Computerprogramm zur Erstellung von Raster-Verbreitungskarten, wird vorgestellt.

Summary

Aims and methods of lichen mapping in Schleswig-Holstein (N. Germany). A short outline of the current lichen research project in Schleswig-Holstein is given. DISMAP, a computer program designed for the storage and presentation of field data and distribution maps, is briefly described.

1. Einleitung

Schleswig-Holstein, das nördlichste Bundesland der Bundesrepublik Deutschland, wird im Norden durch die Staatsgrenze zu Dänemark, im Süden durch den Verlauf der Elbe, die Landesgrenze zu Hamburg und die Staatsgrenze zur ehemaligen Deutschen Demokratischen Republik begrenzt (Abb. 1). Es nimmt den südlichen Teil der sogenannten Cimbrischen Halbinsel ein, die den nördlichsten Ausläufer des mitteleuropäischen Tieflandes bildet. Nach ihrer Entstehungsgeschichte, ihrem geologischen Aufbau und ihrer ursprünglichen Vegetation können drei Landschaftstypen unterschieden werden: das westliche Marschland entlang der Nordseeküste, die Geest, deren sandige Böden ehemals vor allem Eichen-Buchenwald und Heidevegetation trugen, und das vom Buchenwald geprägte Östliche Hügelland. Der Lage zwischen Nord- und Ostsee verdankt Schleswig-Holstein, das „Land zwischen den Meeren", sein mildes, subatlantisch geprägtes Klima.

Die ersten ausführlicheren Angaben über Flechtenvorkommen in Schleswig-Holstein gehen auf Weber (1780) zurück, der in seinen „Primitiae Florae Holsaticae" eine geringe Zahl von Flechtenarten erwähnt. Aus dem 20. Jahrhundert liegen zusammenfassende floristische Werke von v. Fischer-Benzon (1901) und Erichsen (1957) vor. Im Verlauf der letzten 15 Jahre dehnten auch Lichenologen aus benachbarten Ländern ihre Untersuchungen auf Schleswig-Holstein aus und trugen so zur Kenntnis der hiesigen Flora und Vegetation bei (z. B. Søchting & Ramkær 1982, Brand & Ketner-Oostraa 1983). Eine aktuelle Checkliste der Flechten des Landes wurde vor kurzem zusammengestellt (Jacobsen 1988).

Seit 1983 werden durch Mitglieder des Botanischen Instituts der Universität Kiel Daten zum Vorkommen von Flechten im Landesgebiet erhoben, seit 1984 mit dem Ziel der Erstellung von Verbreitungskarten. Das laufende Forschungsprojekt wurde 1987 initiiert und wird vom Minister für Natur, Umwelt und Landesentwicklung des Landes Schleswig-Holstein finanziell gefördert. Ein ausführlicher Abschlußbericht ist für den Beginn des Jahres 1991 vorgesehen.

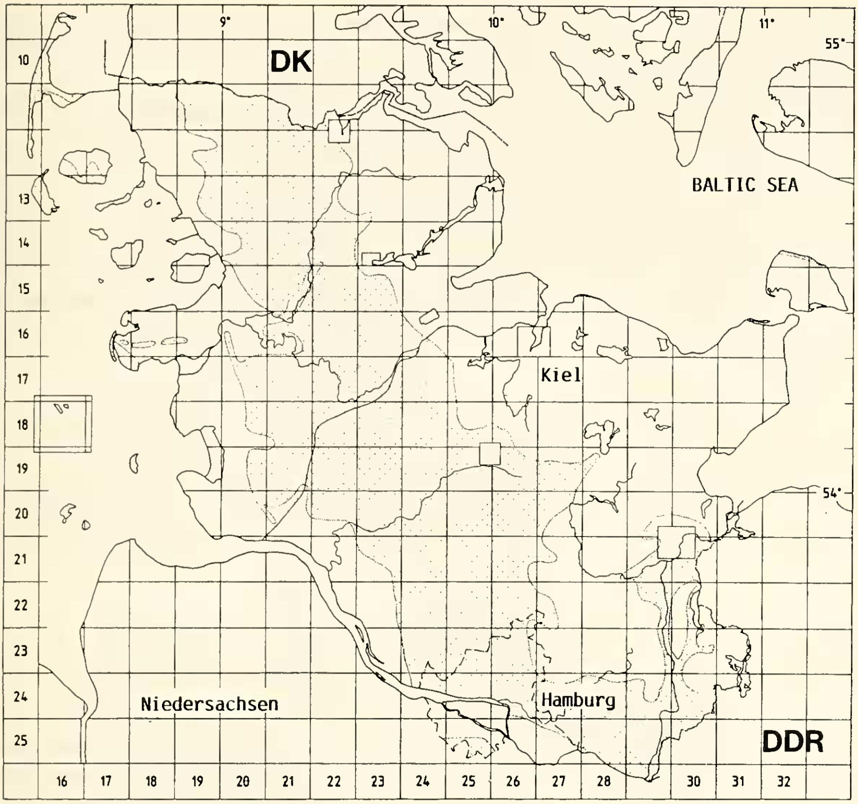
Tab. 1. Überblick über die Ziele der Flechtenkartierung in Schleswig-Holstein. – [Major steps in the Schleswig-Holstein lichen project.]

Allgemeiner Ablauf von Kartierungsprojekten	Arbeitsschritte bei der Flechtenkartierung in Schleswig-Holstein
1. Kartierung der aktuellen Flora	Erstellen einer kumulativen „Checkliste" für das Kartierungsgebiet Erstellen einer aktuellen „Checkliste" (Daten nach 1983) Floristik (inkl. ökologischer Charakterisierung der Arten) Gesamtkartierung von Schleswig-Holstein Großmaßstäbliche Kartierung in Flensburg (85 000 Einwohner)
2. Bewertung der Veränderungen von Flora und Vegetation	Ermittlung von Verbreitungsmustern Ermittlung von zeitlichen Veränderungen der Verbreitungsmuster Faktorenanalyse (Umweltverschmutzung, Zerstörung von Habitaten, etc.)
3. Interpretation der Ergebnisse zu administrativen Zwecken	Empfehlungen für: – Naturschutz (Ausweisung von Schutzgebieten, etc.) – Umweltschutz – örtliche Planungsvorhaben

2. Ziele der Flechtenkartierung in Schleswig-Holstein

Tabelle 1 gibt einen zusammenfassenden Überblick über die verschiedenen Teilziele des laufenden Projekts. Die derzeitigen Untersuchungen zielen in erster Linie auf ein umfassenderes Verständnis der Faktoren ab, welche die Verbreitung von Flechten im Landesgebiet beeinflussen. Da im Laufe der letzten Jahrzehnte in dieser Hinsicht keine kontinuierlichen Arbeiten durchgeführt wurden, war – und ist – ein erhebliches Maß an „Grundlagenforschung" nötig, bevor die Signifikanz und auch die Bedeutung von Veränderungen in der Vegetation richtig beurteilt werden können. Regionale Kartierungsaktivitäten können dazu beitragen, die wechselseitigen Beziehungen zwischen Flechtenarten und ihrer Umwelt aufzuklären; darüber hinaus können im Rahmen von Kartierungen auch Hinweise auf Gebiete gewonnen werden, die erhöhten Schadstoffbelastungen oder anderen anthropogenen Einflüssen ausgesetzt sind (z. B. Rose 1973, Türk 1982). Die Auswertung von Verbreitungskarten kann somit zu einer weiteren Informationsquelle für administrative Maßnahmen des Natur- und Umweltschutzes werden.

Die Kartierung der Flechten in Schleswig-Holstein ist mittlerweile recht weit fortgeschritten, wie durch exemplarische Verbreitungskarten belegt werden kann (s. u.). Neben der flächendeckenden Kartierung des Bundeslandes wurde Flensburg, eine Stadt mit ca. 85 000 Einwohnern, als Beispiel für ein intensiv zu untersuchendes Siedlungsgebiet ausgewählt. Die Geländearbeiten in Flensburg verfolgten vor allem das Ziel, die Aussagefähgkeit epiphytischer Flechtenvorkommen zu prüfen und eine Basis für zukünftige, vergleichende Bioindikations-Untersuchungen der Luftqualität zu schaffen. Während der detaillierten Kartierung, die vor kurzem abgeschlossen



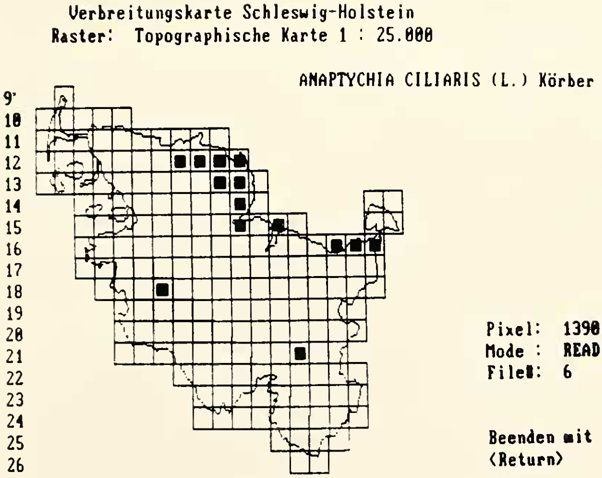


Abb. 1. (oben) Grundkarte der floristischen Kartierung in Schleswig-Holstein. – [Standard map used in the Schleswig-Holstein lichen project.]

Abb. 2. (unten) Monochrome Bildschirmausgabe einer Rasterkarte durch das Computerprogramm DISMAP. – [Monochrome screen display of a grid map generated by the computer program DISMAP.]

wurde, konnten insgesamt 91 epiphytische Flechtenarten an Straßenbäumen innerhalb der Stadtgrenzen aufgefunden werden; dies ist eine unerwartet große Zahl, die auf eine hohe Diversität der lokalen Flora schließen läßt.

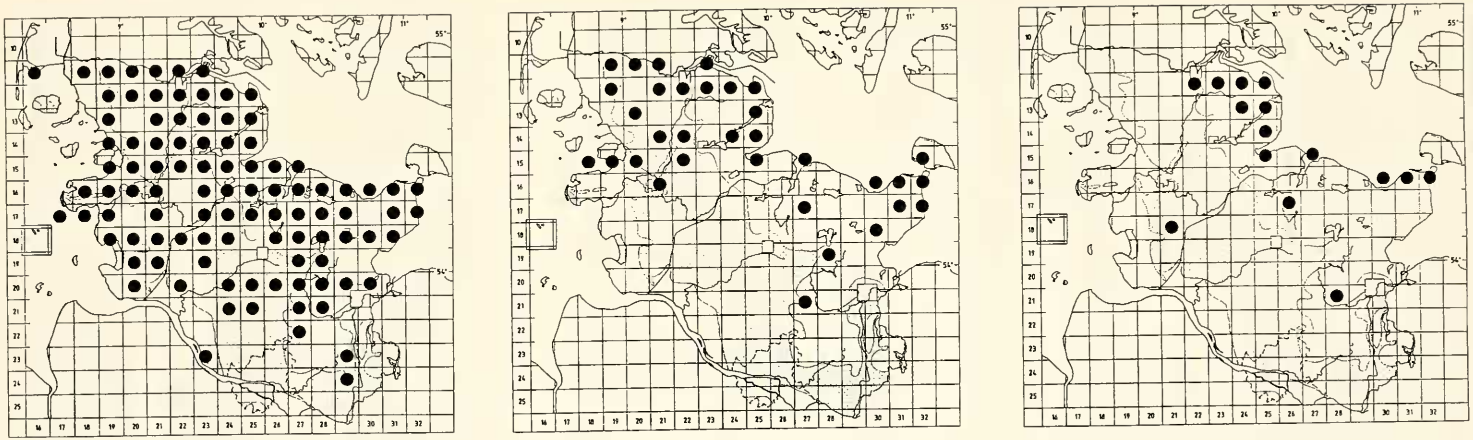
Die gleichzeitige Durchführung von lokalen und regionalen Kartierungsarbeiten bedeutet einen erheblichen Vorteil. Die Erfassung der Flechtenvorkommen eines größeren Gebietes bietet die Möglichkeit, alle vorhandenen Arten unter den verschiedensten Wuchsbedingungen zu studieren, was z. B. die Ansprache von Schadformen wesentlich erleichtert. Eine intensive Untersuchung stark belasteter oder artenarmer Gebiete sollte nur unter genauer Kenntnis der regionalen Flora erfolgen (vgl. Wirth 1988: 102); die Kenntnis der normal entwickelten Vegetation ist eine Voraussetzung für die korrekte Interpretation verarmter oder geschädigter Flechtengemeinschaften.

3. Methoden der Flechtenkartierung in Schleswig-Holstein

In der routinemäßigen Erfassung von Verbreitungsdaten werden für alle im Gelände angetroffenen Arten Angaben zur Lokalität (Koordinaten) und zum Substrat sowie Querverweise auf Herbarbelege festgehalten. Die resultierenden Rasterkarten stellen die Artverbreitung in Grundfeldern von ca. 11 km × 11 km Fläche dar.

Die derzeit verwendete Grundkarte besitzt die Rastereinteilung der Amtlichen Topographischen Karte 1 : 25 000, d. h. das Meßtischblatt-Raster. Es ist jedoch beabsichtigt, die vorliegenden Daten auch in das internationale UTM-System zu übertragen, dessen Gebrauch z. B. in den skandinavischen Ländern verbreitet ist. Da die regionale und nationale Kartierung der Phanerogamen in der Bundesrepublik sich so gut wie ausschließlich auf das System der Topographischen Karten stützt, würde eine Abweichung von diesem Raster in der bundesweiten Kartierung der Flechten einen Verlust der Kompatibilität zur Kartierung der Blütenpflanzen bedeuten. Für die Darstellung von Flechten-Verbreitungskarten auf europäischer Ebene ist jedoch aus Gründen der Standardisierung dem UTM-System der Vorzug zu geben.

Im Hinblick auf die Zusammenfassung der in Schleswig-Holstein erhobenen Daten wurde das Computerprogramm DISMAP erstellt, das der Bearbeitung und Präsentation von Verbreitungskarten dient. DISMAP wurde für IBM-kompatible Computer geschrieben (PC-AT, Betriebssystem MS-DOS). Mehrere Graphik-Adapter werden unterstützt; bereits mit einer relativ einfachen Hardware-Konfiguration wird eine befriedigende graphische Wiedergabe erzielt. Eines der besonderen Leistungsmerkmale des Programms ist die Möglichkeit, die Korrektur von einfach strukturierten Datenfiles und das Editieren von Verbreitungskarten direkt am Bildschirm durchzuführen, und zwar durch einfaches Hinzufügen und Löschen von Fundpunkten in der Kartengraphik. Darüber hinaus ist es dem Benutzer möglich, in allen Datensätzen bzw. Karten im schnellen Vor -und Rücklauf zu „blättern“. Routinen für die komfortable Eingabe von Artenlisten für ein Grundfeld oder Grundfeldlisten für eine Art stehen zur Verfügung. Weitere Funktionen erlauben den direkten Zugriff auf numerische Files (z. B. zum Sortieren von Datenmengen); nicht mißverständliche Artnamen werden automatisch erkannt und zur vollen Länge ergänzt. Die Bildschirm-Symbole für Hintergrundflächen und Fundpunkte sind frei definierbar, und es ist möglich, das Programm an veränderte Datenstrukturen anzupassen.



Parmelia acetabulum (Necker) Duby

Physconia distorta (With.) Laundon

Anaptychia ciliaris (L.) Körber

Abb. 3. Aktuelle Verbreitung (Nachweise 1983–1989) dreier epiphytischer Flechtenarten in Schleswig-Holstein. – [Preliminary distribution maps (records 1983–1989) of three epiphytic lichen species in Schleswig-Holstein.]

Eine DISMAP-Version, die benutzerdefinierte Flächen als Rasterkarten auszugeben vermag, ist zur Zeit in Entwicklung. Abb. 2 zeigt die monochrome Bildschirm-Wiedergabe einer Verbreitungskarte (Darstellung durch Hercules-Adapter). Eigenschaften und Anwendungsmöglichkeiten floristischer Datenbanken werden von DIEDERICH (dieser Band) ausführlich erläutert. Es wäre wünschenswert, in naher Zukunft eine Übereinkunft bezüglich des Formats von Verbreitungsdateien zu erzielen, so daß der Zugriff auf standardisierte Datenfiles auch mittels unterschiedlicher Hard- und Software möglich wird.

4. Allgemeine Anmerkungen

Abb. 3 zeigt die aktuelle Verbreitung (Nachweise 1983–1989) dreier epiphytischer Flechtenarten, die relativ ähnliche ökologische Ansprüche haben: *Parmelia acetabulum*, *Physconia distorta* und *Anaptychia ciliaris*. In der Reihenfolge ihrer ansteigenden Sensibilität gegenüber Luftverunreinigungen ist das Vorkommen dieser Arten zunehmend auf den nordöstlichen Teil Schleswig-Holsteins beschränkt. Sicherlich sind viele Botaniker vertraut mit ähnlich deutlichen Verbreitungsmustern. Für alle, die sich mit der Erfassung von Flechtenvorkommen beschäftigen (und daher vor der Aufgabe stehen, solche Verbreitungsmuster zu interpretieren), wird es nützlich sein, Einzelheiten über das Auftreten bzw. Fehlen von Flechtenarten in anderen Teilen Europas zu erfahren. Die Unterscheidung und korrekte Bewertung ökologischer, klimatischer und anthropogener Faktoren verspricht auf diese Weise einfacher zu werden.

Im Sinne des Vorschlags von TRASS (dieser Band) könnte eine Auswahl gefährdeter Arten zum Gegenstand einer ersten koordinierten Kartierung auf europäischer Ebene gemacht werden. Obwohl noch einige Fragen zur Vorgehensweise offen sind, sollte es möglich sein, in verhältnismäßig kurzer Zeit erste Ergebnisse zu publizieren. Auf diese Weise könnte sowohl den zuständigen Behörden als auch der Öffentlichkeit nahegebracht werden, daß es sich bei der Kartierung der Flechten in Europa nicht nur um eine reizvolle wissenschaftliche Aufgabe, sondern auch um einen Fall der konkreten Anwendung biologischer Forschung handelt.

5. Danksagung

Ich danke Herrn Prof. Dr. L. KAPPEN für die kritische Durchsicht des Manuskripts und Frau M. MEMPEL für die Hilfe bei der Anfertigung der Abbildungen. Frau G. ERNST trug zur Vervollständigung der Verbreitungskarte von *Physconia distorta* bei. Die Kartierungsarbeiten in Schleswig-Holstein erfolgten mit finanzieller Unterstützung des Ministers für Natur, Umwelt und Landesentwicklung des Landes Schleswig-Holstein.

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Stuttgarter Beitr. Naturk.	Ser. A	Nr. 456	161–166	Stuttgart, 31. 12. 1990

Flechtenkartierung in Hamburg

Von Tassilo Feuerer, Hamburg

Mit 2 Abbildungen und 1 Tabelle

Die gegenwärtig noch nicht abgeschlossenen Untersuchungen zur Erfassung der historischen und aktuellen Verbreitung von Flechten im Gebiet der Hansestadt Hamburg liefern unter anderem einen Beitrag zur geplanten Kartierung mitteleuropäischer Flechten. Die Hamburger Kartierung erstreckt sich über einen rechteckigen Kartenausschnitt und umfaßt 30 Meßtischblätter (Top. Karte 1 : 25 000) von TK 2223 bis TK 2628. Auf den dadurch abgedeckten Flächen außerhalb des Stadtgebietes wird jedoch keine vollständige Erfassung aller Arten angestrebt. Die Arbeiten sind in folgende Schritte unterteilt:

1. Erstellung einer Artenliste aus der Literatur,
2. Kartierung der dort angegebenen Fundorte,
3. Revision des Herbarmaterials,
4. Lichenologische Bestandsaufnahme der Naturschutzgebiete,
5. Erfassung der aktuellen Flechtenflora einschließlich der Verbreitung der Chemorassen einzelner Arten,
6. Rekonstruktion der potentiellen natürlichen Flechtenflora Hamburgs.

Eine Kartierung der Hamburger Flechtenflora im 1 x 1 Kilometer-Raster des UTM-Systems ist für die Zukunft geplant und soll im feinmaschigen Biomonitoring die Schadstoffbelastung in dieser durch eine ausgedehnte Flechtenwüste geprägten Stadt widerspiegeln (Abb. 1).

Im Jahr 1989 gab es in Hamburg nach jetziger Kenntnis 63 Arten (Tab. 1), einige davon wachsen nur an einem oder wenigen Fundorten. Insgesamt wurden aus Hamburg seit den ersten Meldungen von Timm (1876) etwa 211 Arten genannt. Die Zahl ist nicht genau feststellbar, da nicht zu allen gemeldeten Taxa Herbarbelege vorliegen. Soweit vorhanden, muß auf Herbarmaterial aus Gebieten außerhalb Hamburgs zurückgegriffen werden, um das Artverständnis des jeweiligen Autors zu erhellen. Die Bearbeitungen der artenreichen oder schwierigen Gattungen wie *Cladonia, Lecidea* s. l. oder *Opegrapha* wird zu einer Reduktion der Artenzahl führen. Andererseits gab es früher auch in Hamburg Vorkommen vieler Flechtenarten, die erloschen, bevor sie registriert werden konnten. Jacobsen (1987) nennt in seiner Checkliste 607 Arten für das Bundesland Schleswig-Holstein. Die Liste wurde aus der Zusammenstellung von Erichsen (1957) kompiliert, formal revidiert und punktuell an Herbarmaterial überprüft. Die Bearbeitung der Gattung *Rhizocarpon* desselben Gebiets durch Feuerer (1987) zeigt exemplarisch, daß sich die Zahl von 607 Arten erheblich verringern wird. Im Fall der Gattung *Rhizocarpon* verblieben von 13 in der Literatur für Schleswig-Holstein genannten Arten schließlich 7 Arten. Eine geschätzte Zahl von etwa 250 Arten der potentiellen natürlichen Flechtenflora erscheint uns für das Gebiet der Hansestadt Hamburg nicht zu hoch gegriffen. In vielen Fällen läßt sich aus der Gesamtverbreitung jeder einzelnen Art in Nord-

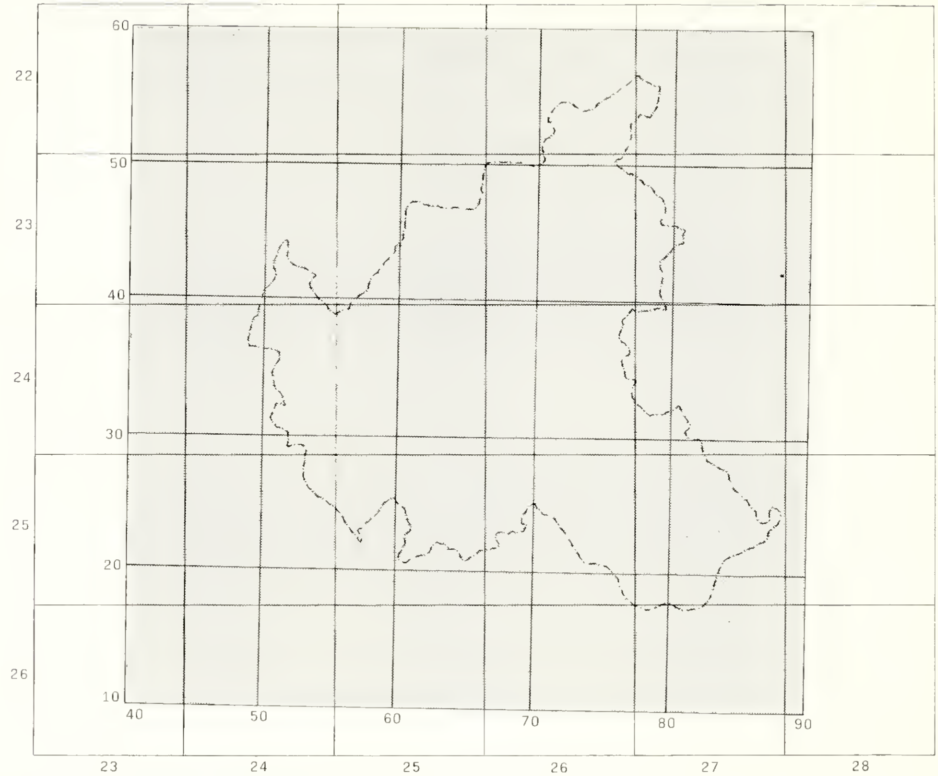

Abb. 1. Die Lage der zur Bearbeitung vorgesehenen UTM-Gitterfläche innerhalb des Schnitts der Topographischen Karten im Minutengitter in der Umgebung der Hansestadt Hamburg.

deutschland ihr historisches Vorkommen in Hamburg wahrscheinlich machen.

Hinsichtlich der Liste der aktuellen Verbreitung ist das Auffinden zusätzlicher Arten zu erwarten. Eine Reihe von Sippen wurde im Stadtgebiet erst kürzlich und nur von einem einzigen Fundort bekannt (*Bryoria fuscescens, Porina chlorotica, Stereocaulon nanodes, S. pileatum, S. saxatilis*). Wie in Hamburg, wurden auch in Berlin (Leuckert & Rux 1988) noch vor kurzem einzelne Exemplare relativ seltener und anspruchsvoller Arten angetroffen. Hier handelt es sich um kärgliche Reste einer einst artenreichen Flechtenflora. Ihr Auffinden, oftmals kurz vor dem endgültigen Erlöschen der Vorkommen, darf nicht dazu veranlassen, den zukünftigen Verlauf des menschlichen Einflusses auf besonders sensitive Organismengruppen positiv zu prognostizieren. Dies gilt erst recht für das Vorrücken wenig empfindlicher Epiphyten in frühere Flechtenwüsten (Kandler & Poelt 1985).

Flechtenerstfunde der letzten Jahre im Hamburger Stadtgebiet sind zum Teil dadurch zu erklären, daß bisherige Kartierungen in diesem Raum sich auf epiphytische Arten beschränkten (Villwock 1956, 1959, 1962, 1984, Förster 1969, Ruge & Förster 1970, Bauer & Solbrig 1981, Schnell & Vietzke 1986, 1988, Vietzke & Schnell 1987), und daß ebenso wie bei den meisten Kartierungen von Großstädten in Mitteleuropa sowohl Gesteins- als auch Erdflechten keine Berücksichtigung

Tab. 1. Im Jahr 1989 in Hamburg kartierte Arten. – Bei Gesteinsflechten wird gegebenenfalls mit Asterisk (*) auf anthropogene Substrate hingewiesen.

Aspicilia contorta (Hoffm.) Krempelh.*
Baeomyces rufus (Hudson) Rebent.
Bryoria fuscescens (Gyelnik) Brodo & Hawksw.
Buellia aethalea (Ach.) Th. Fr.
B. punctata (Hoffm.) Massal.
Caloplaca citrina (Hoffm.) Th. Fr.*
C. decipiens (Arnold) Blomb. & Forss.*
C. holocarpa (Hoffm.) Wade*
C. lactea (Massal.) Zahlbr.*
Candelariella aurella (Hoffm.) Zahlbr.*
C. vitellina (Hoffm.) Müll. Arg.*
Chaenotheca ferruginea (Turner ex Sm.) Migula
Cladonia chlorophaea (Flörke ex Sommerf.) Sprengel
C. coniocraea (Flörke) Sprengel
C. furcata (Hudson) Schrader
C. gracilis (L.) Willd.
C. macilenta Hoffm.
C. ochrochlora Flörke
C. polydactyla (Flörke) Sprengel
C. portentosa (Dufour) Zahlbr.
C. pyxidata (L.) Hoffm.
C. rei Schaerer
Coelocaulon aculeatum (Schreber) Link
Collema crispum (Hudson) Wigg.
C. limosum (Ach.) Ach.
Evernia prunastri (L.) Ach.
Hypocenomyce scalaris (Ach.) Choisy
Hypogmnia physodes (L.) Nyl.
Lecania erysibe (Ach.) Mudd
Lecanora conizaeoides Nyl. ex Crombie
L. dispersa (Pers.) Sommerf.*
L. muralis (Schreber) Rabenh.*
Lecidea fuscoatra (L.) Ach.
Lecidella stigmatea (Ach.) Hertel & Leuckert*
Lepraria incana (L.) Ach.
Micarea denigrata (Fr.) Hedl.
Mycobilimbia sabuletorum (Schreber) Hafellner
Parmelia saxatilis (L.) Ach.
P. sulcata Taylor
Peltigera didactyla (With.) Laundon
P. polydactyla (Necker) Hoffm.
Phaeophyscia nigricans (Flörke) Moberg*
P. orbicularis (Necker) Moberg*
Physcia adscendens (Fr.) Oliv.
P. caesia (Hoffm.) Fürnr.*
P. tenella (Scop.) DC.
Platismatia glauca (L.) W. Culb. & C. Culb.
Pleurosticta acetabulum (Necker) Elix & Lumbsch
Porina chlorotica (Ach.) Müll. Arg.
Porpidia crustulata (Ach.) Hertel & Knoph*
Rhizocarpon obscuratum (Ach.) Massal.*
Rinodina gennarii Bagl.*
Saccomorpha icmalea (Ach.) Clauz. & Roux
Sarcogyne pruinosa (Sm.) Mudd*
Staurothele catalepta (Ach.) Blomb. & Forss.*

Stereocaulon nanodes Tuck.*
S. pileatum Ach.*
S. saxatile Magnusson*
Trapelia coarctata (Sm.) Choisy*
Verrucaria muralis Ach.*
V. nigrescens Pers.*
Xanthoria candelaria (L.) Th. Fr.
X. parietina (L.) Th. Fr.

fanden (z. B. EHRENDORFER et al. 1971, GOPPEL 1976; KILIAS 1974, KLEMENT 1958, NATHO 1964, SAUBERER 1951, SCHMID 1956, SKYE 1968 sowie STEINER & SCHULZE-HORN 1955).

Wie zwei Beispiele aus Hamburg zeigen, können jedoch gerade Gesteinsflechten bedeutsame Hinweise auf Schadeinflüsse liefern. *Candelariella vitellina* ist eine acidophytische Art mit weiter ökologischer Amplitude, die auch nitratreiche Standorte nicht meidet. Die Art ist auf Mörtel im Stadtzentrum häufiger als am Stadtrand und um so regelmäßiger anzutreffen, je älter dieses Substrat ist. Mörtel reagiert gewöhnlich basisch und schließt dadurch *C. vitellina* vom Wachstum aus. Wir nehmen an, daß die sauren Niederschläge eine fortschreitende Entkalkung bewirken, die im Stadtzentrum und bei zunehmender Einwirkdauer an Bedeutung gewinnt. Eine weitere Krustenflechte, *Staurothele catalepta,* spielt eine Rolle bei der Beurteilung der Elbwasserqualität. ERICHSEN berichtete im Jahr 1917 (S. 69) von einer Verbreitungslücke zwischen dem Stadtteil Moorfleth im Osten und der westlichen Stadtgrenze bei Wedel. Er führt das lokale Fehlen der Art, die in diesem Raum mehr oder weniger überspülte Gesteinsblöcke der Uferbefestigung der Unterelbe besiedelt, auf die beträchtliche Verschmutzung des Elbwassers zurück. Die Sippe konnte neuerdings innerhalb dieser damaligen Lücke an der Anlegestelle Teufelsbrück, 8 Kilometer vom Stadtzentrum und 10 Kilometer innerhalb der westlichen Stadtgrenze, gefunden werden. Es bleibt zu untersuchen, ob dies als Hinweis für eine Verbesserung der Wassergüte aufzufassen ist.

Generell ist die Verbreitung von epilithischen Krustenflechten in Städten von besonderem Interesse, weil hier, insbesondere nach der Vernichtung epiphytischer Flechten durch saure Niederschläge ein zweites, möglicherweise noch schwieriger zu lösendes Problem sichtbar wird, nämlich die regionale Grenzen übersteigende Eutrophierung. Die Bestandsentwicklung in Abhängigkeit von verschiedenen Substrattypen (Abb. 2) zeigt, daß die Artenzahlen aller Substratklassen seit 1876 zurückgingen, bis auf die Gruppe der basiphytischen Gesteinsflechten, die in ausgedehntem Maß Beton und Kunststeine besiedeln. Diese Arten können fast alle als ziemlich bis extrem nitrophytisch gekennzeichnet werden. Durch die Pufferwirkung des Kalkes kann sich auf Beton eine individuenreiche Flechtenvegetation entwickeln. In solchen Großstädten, deren Luft weniger SO_2-belastet ist, entwickelt sich auch an Bäumen eine reiche nitrophytische Flechenvegetation. Dies gilt besonders ausgeprägt für München, das in diesem Punkt in deutlichem Gegensatz zu Hamburg steht.

Die Untersuchungen der Hamburger Flechten zeigen, daß die Luftschadstoffbelastung nach wie vor durch intensive Bemühungen reduziert werden muß. Darüber hinaus sollten Standorte von besonderem Interesse, nämlich die an Gesteinsflechten relativ reichen Friedhöfe und die Terrassenmauern der Elbvororte um Blankenese durch individuelle Maßnahmen geschützt werden. Nach der fachgerechten Information der Öffentlichkeit müssen realistische Schutzvorschläge erarbeitet werden.

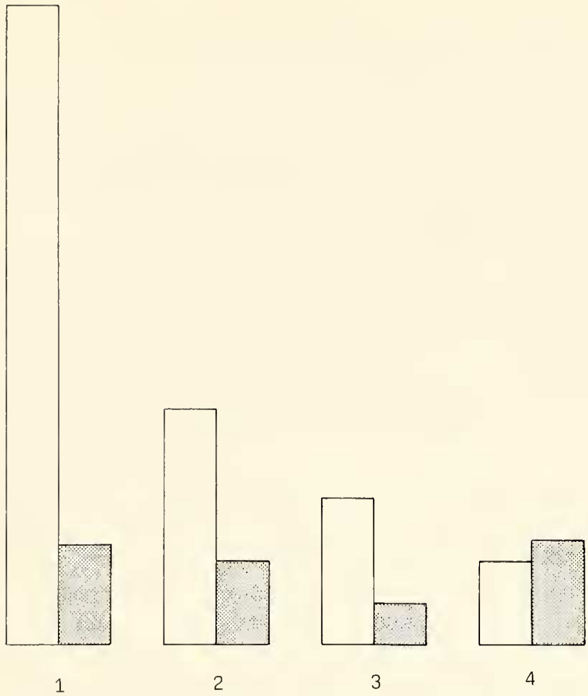

Abb. 2. Abhängigkeit der Bestandesentwicklung Hamburger Flechten vom Substrattyp. Die Balkenhöhen repräsentieren die Artenzahlen. – *1.* Epiphyten 122:19, *2.* Erdflechten 45:16, *3.* Acidophytische Gesteinsflechten 28:8, *4.* Basiphytische Gesteinsflechten 16:20. – *Rechts* jeweils das Jahr 1989 betreffend, *links* unter Einschluß aller seit 1876 angetroffenen Arten. Die Zuordnung der einzelnen Arten zu den Substratklassen ist in einigen Fällen problematisch.

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Das Flechtenkartierungsprojekt in Westfalen

Von Elmar Woelm, Osnabrück

Westfalen liegt im Nordwesten der Bundesrepublik Deutschland. Die Region kann in drei Teile gegliedert werden: das Tiefland im Nordwesten, die sogenannte Münstersche Bucht; das Weser-Bergland im Nordosten; der im Süden gelegene Abschnitt des Rheinisch-Westfälischen Schiefergebirges, das Sauerland. Auch die bedeutende, im Westen gelegene Industrieregion des Ruhrgebietes ist Teil von Westfalen.

In Westfalen kann sich die Lichenologie auf eine alte solide Basis stützen. In der Mitte des 19. Jahrhunderts publizierte Beckhaus (1855/56, 1856, 1857, 1859) die Ergebnisse seiner Erforschung der westfälischen Kryptogamen und legte eine Liste von 376 Flechtenarten vor. Wenige Jahrzehnte später veröffentlichte der Pfarrer Lahm eine umfassende Arbeit über die Flechtenflora von Westfalen, die seinerzeit 689 Flechtenarten zählte (Lahm 1885).

Weitere bedeutende in Westfalen tätige Lichenologen waren Zopf und Tobler. Sie arbeiteten allerdings kaum floristisch und waren daher für die Erforschung der Flechtenflora Westfalens weniger maßgebend. Flechtenfloristisch war die Periode Beckhaus-Lahm in den Jahren zwischen 1850 und 1890 am fruchtbarsten. Seit dieser Zeit wurden nur noch wenige Flechtenfunde aus Westfalen publiziert.

Infolge der Eignung von Flechten als Indikatoren der Luftverunreinigung ist in letzter Zeit das Interesse an Flechten in Westfalen wiedererwacht. 1983 fand ein erstes Treffen von Freunden der Lichenologie im Westfälischen Museum für Naturkunde in Münster statt. In den folgenden Jahren wurden regelmäßig Arbeitstreffen und Exkursionen abgehalten, um die Untersuchungen wieder aufzunehmen und zu intensivieren. Schließlich wurde 1985 ein „Flechtenkundlicher Arbeitskreis Westfalen" gegründet und das Flechtenkartierungsprojekt von Westfalen offiziell gestartet.

Ziel des Kartierungsprojektes ist die Registrierung aller im Gebiet vorkommenden Flechtenarten und die Darstellung ihrer Verbreitung in Rasterkarten. Zusätzlich soll ökologischen Fragestellungen nachgegangen werden.

Als Gitternetz wird wie bei allen weiteren Flechtenkartierungsprojekten der Bundesrepublik (Philippi & Wirth 1973, Wirth 1984) ein Netz aus Längen- und Breitengraden mit einem Abstand der Gitterlinien von 10 bzw. 6 Minuten verwendet. Die Kartierungseinheiten entsprechen somit den Kartenausschnitten der Topographischen Karte 1:25000 (sog. Meßtischblätter). Im Mittel haben diese Kartierungseinheiten in Westfalen eine Größe von 11,6 × 11,2 km (130 km²). In Westfalen existieren 210 dieser Grundfelder mit einer Gesamtfläche von rund 24 000 km².

Bei der Kartierung werden die untersuchten Lokalitäten in der Topographischen Karte festgehalten und numeriert. Von jeder Lokalität wird ein Protokoll über die aufgefundenen Arten, die topographischen Verhältnisse und die Standortbedingungen angefertigt, so daß die Lokalität jederzeit wieder aufgesucht werden kann. Die aufgefundenen Arten werden entweder individuell aufgelistet oder in Compu-

terlisten, die die häufigeren Arten enthalten, markiert. Diese Computerlisten können entsprechend dem lichenologischen Kenntnisfortschritt laufend erweitert werden.

Die Nachweise werden mit Hilfe von dBASE in IBM-Personal-Computern gespeichert. Anstelle der früher verwendeten Checklists der British Lichen Society benutzen wir nun Computerausdrucke für alle behandelten Grundfelder. Wir hoffen, in Kürze über ein Programm zu verfügen, mit dessen Hilfe auch Verbreitungskarten ausgedruckt werden können.

So besteht unsere Datenbank aus vier Komponenten:

1. Artenliste für jeden Fundort,
2. Topographische Karten mit Fundorten,
3. Artenliste für jedes Grundfeld,
4. Rasterkarten für jede Art.

Die wachsenden Belastungen, wie sie durch Intensivierung von Land- und Forstwirtschaft, Industrialisierung und Bebauung verursacht werden, hatten auch in Westfalen ihre Auswirkungen auf die Flechtenflora. Im Vergleich mit anderen Bereichen der Bundesrepublik sind diese negativen Effekte überdurchschnittlich stark. Viele empfindlichere Flechtenepiphyten, wie *Usnea*- und *Ramalina*-Arten, *Anaptychia ciliaris, Parmelia caperata* und *Lobaria*-Arten sind ausgestorben oder extrem selten geworden. In einigen Teilen Westfalens ist inzwischen selbst die recht toxitolerante *Hypogymnia physodes* selten. Dies illustriert, daß die Flechtenkartierung in Westfalen ein Wettlauf mit der Zeit ist. Hauptproblem ist der Mangel an Mitarbeitern an der Kartierung. Die zur Zeit tätigen Kartierer sind Amateure mit entsprechend geringen zeitlichen und – da jegliche finanzielle Unterstützung noch aussteht – finanziellen Möglichkeiten.

Zur Zeit liegen Daten von 116 Grundfeldern vor. Keines der Grundfelder wurde wirklich gründlich untersucht. Bislang wurden über 250 Arten registriert. Die tatsächliche Artenzahl dürfte wesentlich höher sein.

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Die Verbreitung von Flechten im Taunus – Ökologie und Geschichte

Von Heribert Schöller, Frankfurt

Mit 5 Abbildungen

1. Der Naturraum Taunus

Der Taunus liegt etwa in der Mitte der Bundesrepublik Deutschland. Er erstreckt sich von 49°59' und 50°33' nördlicher Breite bis 7°39' und 8°33' östlicher Länge von Greenwich, etwa zwischen den Städten Frankfurt/Main und Wiesbaden im Süden und Koblenz und Gießen im Norden. Die Ausdehnung in Nord-Süd-Richtung beträgt damit etwa 40 km, die in Ost-West-Richtung 70 km. Dies ergibt eine Gesamtfläche von ca. 2800 km^2 (Abb. 1). Das Mittelgebirge steigt von 70–80 m im Mittelrheingraben bis 879 m über N.N. (Großer Feldberg) an. Oberdorfer (1983) und Grummann (1963) rechnen den Taunus zum Landschaftsraum „Rheinisches Schiefergebirge".

Der größte Teil des Gebirges ist devonischen Ursprungs. Der West- oder Rheintaunus wird von Ton- oder Bänderschiefern beherrscht. Dieser Gebirgsteil besteht heute aus einer auf ungefähr 400 m über N.N. gelegenen Hochfläche mit tief und eng eingeschnittenen Kerbtälern. Der Ost- oder Hochtaunus besitzt Tonschiefer, Grauwackesandstein oder Porphyroidschiefer. Er ist ein teilweise zerklüftetes Mittelgebirge mit tiefen Tälern und Erhebungen zwischen 450 und 700 m über N.N. Die Nord- und Südbereiche des Taunus sind geologisch vielfältiger und mit z. T. kalkigen Sanden und Mergeln des Tertiärs jünger. Die Südflanke wird von Ost nach West von einem Quarzitband durchzogen, welches zur Untermainebene abgrenzt.

Das Klima ist für ein solch kleines Gebiet relativ abwechslungsreich. Die mittlere Januartemperatur schwankt zwischen 1.2 °C im Rheintal (Lorch, 75 m) und −2.7 °C im Hochtaunus (Kleiner Feldberg, 825 m), die Julitemperaturen zwischen 18.0 °C und 13.8 °C (Jahresmittelwerte: 9.4 °C bzw. 5.6 °C). Die Niederschlagshöhe beträgt 580 mm in Lorch/Rh. und 965 mm am Kleinen Feldberg und ist für Westdeutschland relativ niedrig. Im Rheintaunus hat das Regionalklima einen eigenen Charakter: Die engen, tiefen Kerbtäler besitzen Kältelöcher und weisen sich durch besonders hohe Luftfeuchtigkeitswerte aus. Der nächtliche Taufall macht hier 10% des Jahresniederschlags aus (Schulss 1933). Das Gebiet ist das flechtenreichste des gesamten Taunus.

2. Historisches

Flechtenfloristisch ist der Taunus in jüngerer Zeit kaum bearbeitet worden. Ein Grund hierfür mag die Flechtenarmut sein, abgesehen von bestimmten, relativ kleinen Zonen. Mitte bis Ende des vorigen Jahrhunderts herrschten offenbar ganz andere Verhältnisse. Die Literatur aus jener Zeit weist auf einen enormen Flechtenreichtum hin. Flechtenkundler wie Bayrhoffer (1849), Genth (1836), Bagge & Metzler (1865) und Uloth (1861) haben sich um die Beschreibung der Kryptogamenflora Hessen-Nassaus sehr verdient gemacht und geben ein Zeugnis von dem

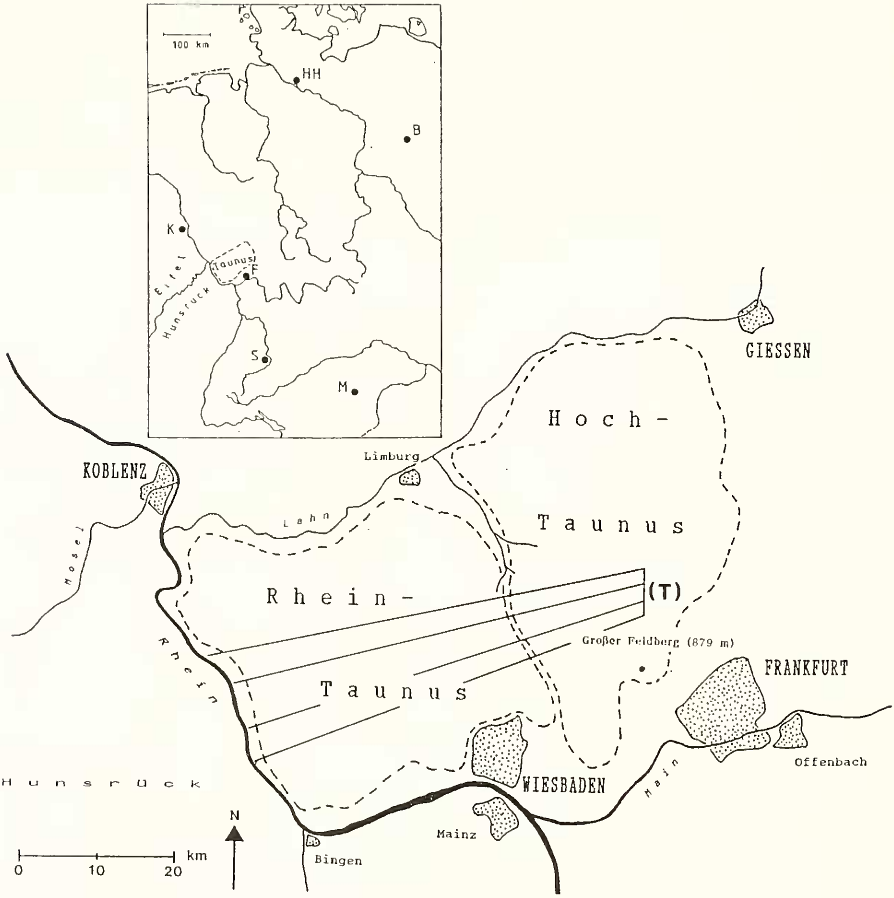


Abb. 1. Übersichtskarte von Mitteleuropa und dem Taunus. – Entlang des Transektes [*T*] wurde die Verbreitung der Flechten vom Mittelrheingraben zum Hochtaunus untersucht.

ungewöhnlichen Flechtenreichtum der Region. KLEMENT (1964) berichtet von der Attraktivität hessischer Naturstandorte für Lichenologen des letzten Jahrhunderts. Doch auch unbekanntere Forscher wie der Geologe ROLLE und sein Freund, der Hobbybotaniker WILL, sammelten im Taunus Flechten (MARTIN & USCHMANN 1969). Letzterer legte ein umfangreiches Flechtenherbar an. Es enthält mehr als 400 Arten, über die Hälfte davon stammt aus dem Osttaunus bei Bad Homburg. Große, Apothecien tragende Lager der Lungenflechte (*Lobaria pulmonaria*) oder auch fruchtende Exemplare von *Evernia prunastri* geben einen Hinweis darauf, wie viel günstiger die Bedingungen für Flechten vor 100 Jahren in diesem Raum gewesen sein müssen (Nomenklatur für diese und im folgenden genannten Arten vgl. WIRTH 1987). *Teloschistes chrysophthalmus* kam, wenn auch selten, im Frankfurter Umland vor. Dies sind nur einige wenige Beispiele bemerkenswerter Flechtenfunde aus früherer Zeit.

3. Die aktuelle Situation

Heute ist der Taunus einschließlich der angrenzenden Gebiete insgesamt sehr flechtenarm. Durch seine geringer ausgeprägte Ozeanität ist er noch stärker verarmt als z. B. die nordwestlich gelegene Eifel. Angesichts derartiger bedauerlicher Verluste in der Flora, die ähnlich auch die Gefäßpflanzen betreffen, drängt sich die Frage nach den Ursachen dieses Wandels auf. Der negative bis vernichtende Einfluß von schädlichen Immissionen ist seit langem bekannt (z. B. ARNOLD 1891–1902; vgl. NASH III & WIRTH 1988). Daneben gelten aber auch Methoden von Forst- und Landwirtschaft als abträglich. Nicht nur die lufthygienische Situation hat sich in den letzten 150 Jahren großräumig sehr stark gewandelt, auch die Art des Landschaftsverbrauchs hat sich geändert.

Bestimmte Teile des Taunus vom Mittelrhein bis zum Hochtaunus wurden vom Autor besonders intensiv auf ihre Flechtenvegetation hin untersucht. Ziel dieser Arbeit war nicht die flächendeckende Erfassung der Flechtenflora, sondern die Untersuchung von Standorten.

Viele SW-exponierte Hänge sind flachgründig und für forstwirtschaftliche Nutzung ungeeignet. Solche „Grenzwirtschaftswälder" sind z. B. lichte Traubeneichenwälder des Luzulo-Quercetum petraeae mit lückigem und krüppelhaftem Baumbewuchs. Sie können als naturnah eingestuft werden, da sie oft eine über hundertjährige, weitgehend ungestörte Entwicklung hinter sich haben. Geringe Konkurrenzkraft der Gefäßpflanzen in der Krautschicht ermöglicht den Kryptogamen stellenweise einen üppigen Wuchs. Auch die Felsflechten und die Epiphyten sind gut bis mäßig entwickelt. Auf dem Transekt vom Mittelrheingraben zum Hochtaunus ist eine Veränderung in der Flechtenvegetation zu registrieren, die mit mesoklimatischen Unterschieden der einzelnen Hänge zusammenhängt.

Das Mittelrheingebiet ist durch kontinental getönte, trockenwarme Sommer und ozeanisch milde Winter ausgezeichnet. Die Phanerogamenvegetation weist entsprechend submediterrane, pontische und atlantische Elemente auf. Solche Pflanzen dringen nicht oder nur wenige Kilometer in die Seitentäler des Rheins vor (HAEUPLER & SCHÖNFELDER 1988). Auch bestimmte Flechten zeigen einen ähnlichen Verbreitungstyp. Vor allem trockenresistente und wärmeliebende Flechten haben ihren Schwerpunkt in den warmen Rheingegenden: *Caloplaca crenularia, Lecanora campestris, Parmelia somloensis, Umbilicaria grisea, Rhizocarpon viridiatrum, Xanthoria calcicola* u. a. Die Vorkommen von *Umbilicaria grisea* zum Beispiel sind unmittelbar auf das Rheingebiet beschränkt (Abb. 2). *Rhizocarpon viridiatrum* dagegen dringt weit in den Rheintaunus ein, ist aber im Osttaunus nur selten anzutreffen.

Die schadstoffempfindliche, heute in weiten Gebieten selten gewordene *Parmelia caperata* ist im Rheintaunus sehr zahlreich und sowohl epiphytisch als auch epipetrisch gut entwickelt (Abb. 3). Als eine hohe Luftfeuchtigkeit bevorzugende Art meidet sie den Mittelrhein bis auf wenige feuchte Kleinstandorte und fehlt im Hochtaunus ganz. Früher war sie an den Südhängen des Osttaunus zur Mainebene hin recht zahlreich, ist dort aber aufgrund der hohen Schadstoffbelastung heute verschwunden. Kelchflechten (Caliciales) und größere *Cladina*-Rasen haben ebenfalls im Rheintaunus ihren Verbreitungsschwerpunkt. Auch sie waren früher im Hochtaunus zahlreich, leiden aber heute dort sehr unter der intensiven Forst- und Wasserwirtschaft. Arten mit hohen Feuchtigkeitsansprüchen wie *Cystocoleus ebeneus* oder

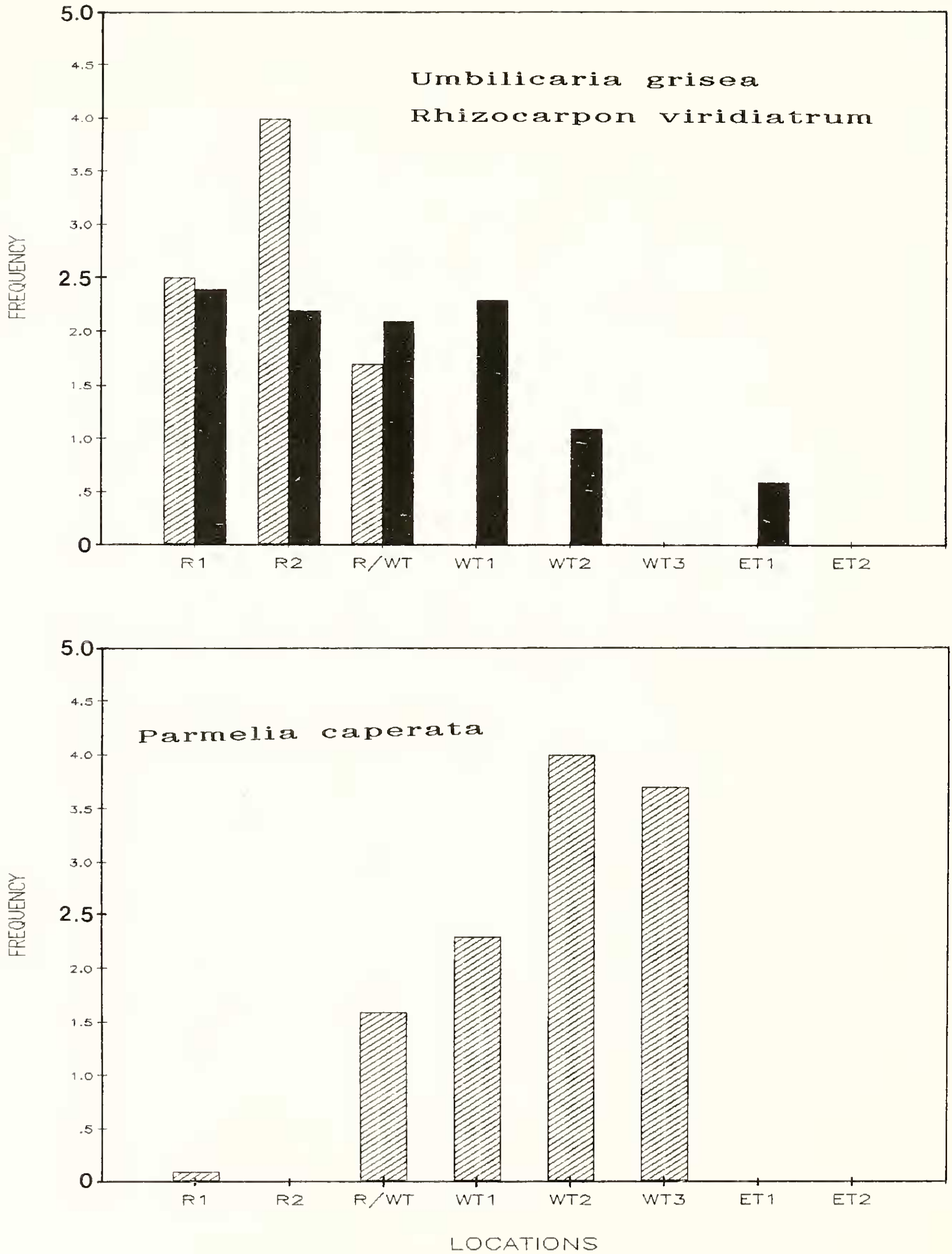
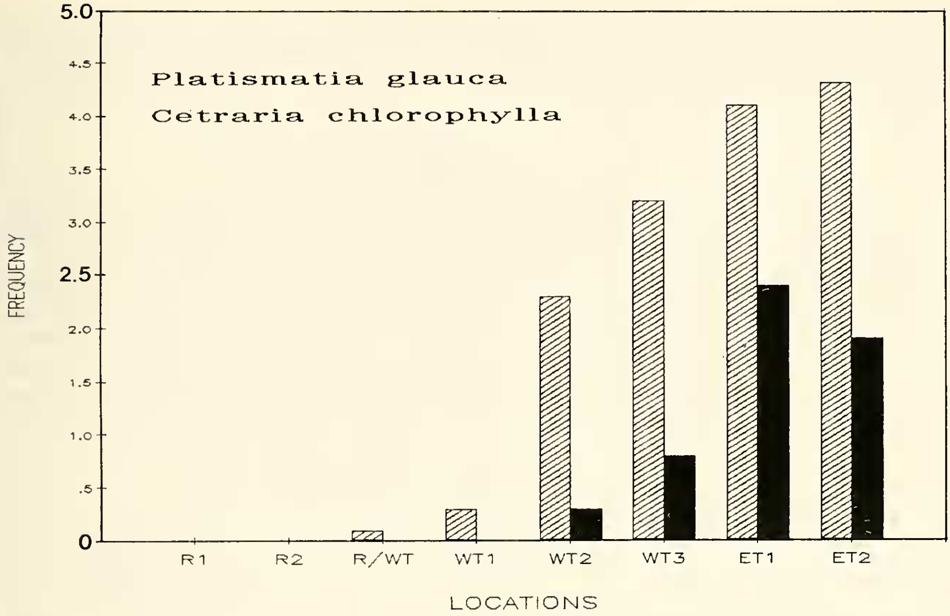


Abb. 2–3. Frequenz-Daten einiger Flechten-Arten entlang des Transektes vom Mittelrhein zum Hochtaunus. – 2. (oben) *Umbilicaria grisea* [schraffiert] und *Rhizocarpon viridiatrum* [schwarz]; – 3. (unten) *Parmelia caperata.*



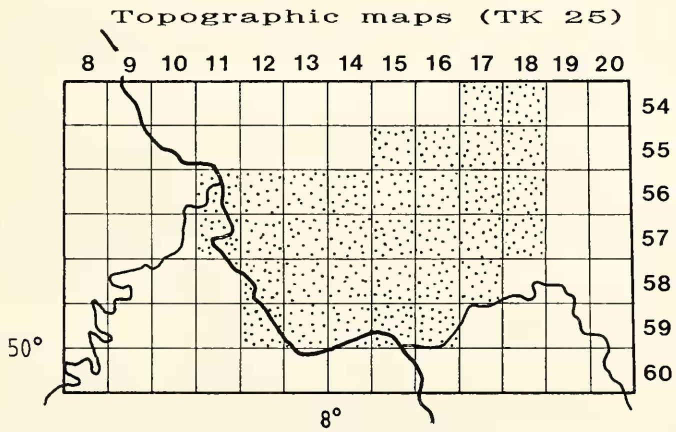


Abb. 4. (oben) Frequenz-Daten von *Platismatia glauca* [schraffiert] und *Cetraria chlorophylla* [schwarz] entlang des Transektes vom Mittelrhein zum Hochtaunus.
Abb. 5. (unten) Übersicht über die Topographischen Karten (TK 25), die für die Rasterpunktkartierung der Flechten vorgesehen sind.

Ochrolechia androgyna sind an den für sie geeigneten Mikrostandorten nicht selten anzutreffen.

Mit zunehmender Höhe finden sich im Hochtaunus in Bergwäldern heimische Arten, die im Rheintal und Rheintaunus fehlen oder kümmerlich entwickelt sind. Montane Arten wie *Platismatia glauca* oder *Pseudevernia furfuracea* sind zahlreich und stellenweise gut entwickelt (Abb. 4). Auch Bartflechten wie *Bryoria fuscescens* und *Usnea filipendula* oder *U. hirta* wachsen in den Hochlagen des Taunus. Die ten-

denziell kontinentale, auf kühle Standorte konzentrierte *Cetraria chlorophylla* fehlt in den Tieflagen fast ganz. Über 700 m N.N. schließlich trifft man, wenn auch selten, in schneesicheren Lagen noch *Cetraria pinastri* an. Sie ist im Taunus nie häufig gewesen.

4. Ausblick

In Zusammenarbeit mit dem Senckenbergischen Forschungsinstitut und durch Auswertung von Herbarmaterial ist geplant, den gesamten Taunus (das sind 33 Meßtischblätter –TK 25–: 24 aus Hessen, 9 aus Rheinland Pfalz) mit seinen Randbereichen: Mittelrhein bis Koblenz, Teile der Untermainebene und des Lahntals sowie der Wetterau und möglicherweise des anschließenden Vogelsbergs zu bearbeiten. Die Verbreitung der Flechten soll in der in Baden-Württemberg (WIRTH 1987) und im Saarland (JOHN 1987) angewandten Form in Rasterkarten erfaßt werden (Abb. 5). Auf diese Weise soll eine Eingliederung in andere, umfassendere Projekte ermöglicht werden.

Das Vorkommen von Arten alleine gibt oft nur ein verzerrtes und manchmal falsches Bild von der realen Vegetation. Neben Präsenzdaten sollten Frequenz und Vergesellschaftungen sowie die Ökologie der Flechten Berücksichtigung finden. Ferner sind Größe und Anzahl der Vorkommen wichtig. Erst die Verknüpfung dieser Daten kann einen ungefähren Eindruck der Frequenz und des Zustandes der Arten und der Vegetation geben.

Bei der Kartierung sollen gleichzeitig auch die Mikrostandorte der Arten statistisch erfaßt werden, um einen Einblick in die Ökologie der Flechten dieses Gebiets zu bekommen. Erfahrungsgemäß können diese in verschiedenen klimageographischen Räumen durchaus differieren.

Darüber hinaus soll auf historische und pflanzengeographische Aspekte ein besonderer Schwerpunkt gelegt werden. Es ist notwendig, alte Forstaufzeichnungen und Katastereinträge exemplarisch auszuwerten, Luftschadstoffkarten zu berücksichtigen und langzeitige Klimaentwicklungen zu betrachten. In Verbindung mit dem Wandel der Landschaft, der Gefäßpflanzen und der Kryptogamenvegetation, besonders der Flechten, soll so versucht werden, ein Modell für den Rückgang vieler Pflanzen des beschriebenen Gebiets zu konstruieren.

Unter Beachtung solch diverser Aspekte der Flechtenverbreitung soll eine umfassende Datenbank der einzelnen Parameter angelegt werden. In Kommunikation mit anderen, möglicherweise ähnlich orientierten Untersuchungen könnten interessante Erkenntnisse über Verbreitung, Ökologie und Geschichte von (mittel-)europäischen Flechten gewonnen werden.

Vielleicht könnte man unter Verwertung aktueller ökologischer Gesichtspunkte und historischen Materials einige Aufschlüsse über den Rückgang und das Aussterben von Flechten erlangen. Sicher ist die Schadstoffbelastung der Luft ein entscheidender Faktor, aber günstige mikroklimatische Bedingungen können nachgewiesenermaßen gewisse Schadstoffwirkungen teilweise kompensieren. Kenntnisse der Standorte der Flechten und der für den Rückgang verantwortlichen historischen Faktoren könnten zu Grundlagen für Schutzprogramme beitragen, wie sie bei Gefäßpflanzen längst akzeptiert und verwirklicht sind.

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Flechtenkartierung in Rheinland-Pfalz

Von Volker John, Bad Dürkheim

Mit 5 Abbildungen

Will man die Erwähnung von Flechten in den alten Kräuterbüchern von H. Bock und seinem Schüler Tabernaemontanus mit berücksichtigen, läßt sich die „Flechtenkunde" in Rheinland-Pfalz bis ins Mittelalter zurückverfolgen. Doch die gezielte und objektgerichtete Flechtenforschung begann hier zwei Jahrhunderte später mit J. A. Pollich (1777). Auf ihn geht beispielsweise die Beschreibung von *Lecanora saxicola* (Pollich) Ach. zurück. Es folgten die Zusammenstellungen von Fingerhuth (1829) mit Flechten aus der Eifel und von Schäfer (1829) mit Angaben aus dem damaligen Regierungsbezirk Trier. Von all diesen Autoren liegen uns aus Rheinland-Pfalz keine Herbarbelege vor.

Das ändert sich mit den Belegen zu den Auflistungen von Bayrhoffer (1849), Genth (1836), Hepp (1844) und Koch (1851). Vielfach sind Ortsangaben in solchen älteren Werken und auf den Scheden so allgemein gehalten, daß eine genaue Zuordnung der Fundpunkte nicht mehr möglich ist. Anders dagegen verhält es sich mit den sehr präzisen Angaben, die etwa ein Jahrhundert später von den beiden lichenologisch aktiven Lehrern E. Müller (1953) in der Pfalz und T. Müller (1965) in der Eifel erarbeitet wurden. Ihre Publikationen sind durch umfangreiche Sammlungen belegt. Eine Zusammenstellung des Rheinland-Pfalz betreffenden lichenologischen Schrifttums findet sich in John (1987).

Die eigentliche Rasterkartierung der Flechten in Rheinland-Pfalz begann erst mit der Einrichtung der Regionalstelle im Pfalzmuseum für Naturkunde in Bad Dürkheim (John 1984). Die Kartierung von knapp der Hälfte der Rasterfelder mit rheinland-pfälzischem Gebietsanteil wurde von diesem Zeitpunkt an vom Ministerium für Umwelt des Landes Rheinland-Pfalz gefördert und im Auftrag des Landesamtes für Umweltschutz und Gewerbeaufsicht durchgeführt. So liegen mittlerweile aus allen das Kartierungsgebiet betreffenden Grundfeldern Meldungen über Flechtenvorkommen vor.

Das Kartierungsgebiet erstreckt sich zwischen 48°58' N und 50°57' N sowie von 6°06' E bis 8°31' E; die Gesamtfläche des Bundeslandes Rheinland-Pfalz beträgt 19 839 km². Diese Fläche wird von 194 Grundfeldern der TK 25 abgedeckt (Topographische Karte 1:25 000; sog. Meßtischblätter) und grenzt an Belgien, Luxemburg, Frankreich sowie die Bundesländer Saarland, Baden-Württemberg, Hessen und Nordrhein-Westfalen. Meldungen aus diesen Grenzbereichen, sofern die Fundpunkte auf der Rasterkarte (vgl. Abb. 1) lokalisierbar sind, werden ebenfalls berücksichtigt. Insbesondere werden alle Funddaten aus dem Saarland übernommen und sollen im Atlas der Flechten von Rheinland-Pfalz integriert erstmals auch in umfassenden Verbreitungskarten dargestellt werden.

Abb. 1 zeigt das Kartierungsgebiet mit den Rasterfeldern entsprechend den Schnittlinien der TK 25. Berücksichtigt werden die Fundpunkte innerhalb der fett durchgezogenen Linien. Die Felder mit rheinland-pfälzischem Gebietsanteil sind

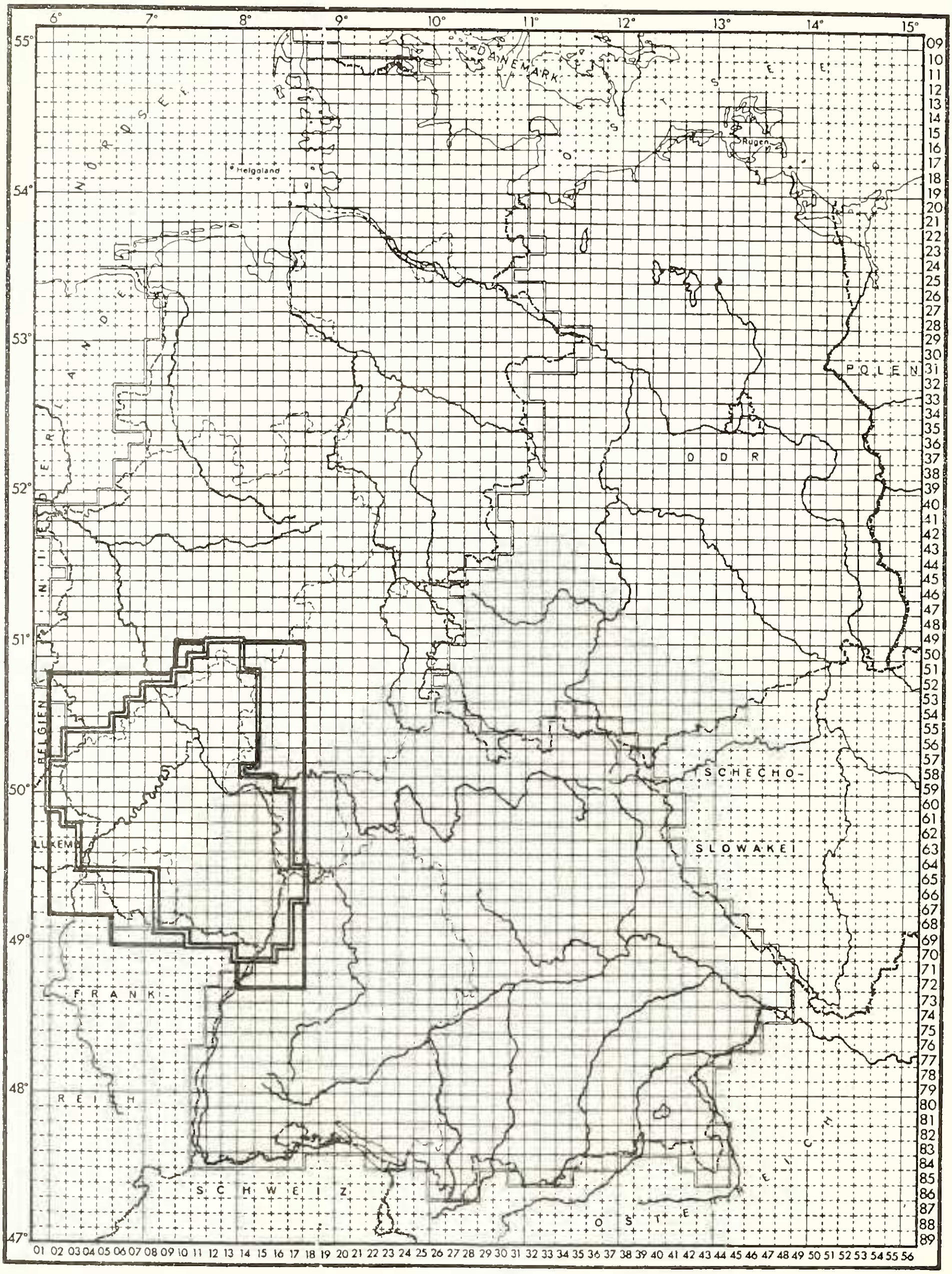


Abb. 1. Untersuchungsgebiet mit berücksichtigten Feldern *(fett umrandet)* sowie die Felder mit rheinland-pfälzischem Gebietsanteil *(Doppellinie)*.

durch eine Doppellinie gekennzeichnet. Dieses Raster wurde gewählt, da es beim ersten Aufruf zu einer Kartierung der Flechten in der Bundesrepublik (PHILIPPI & WIRTH 1973) empfohlen wurde und daher eine Umstellung auf andere Raster unzweckmäßig und verwirrend sein würde (vgl. JOHN 1986).

Die Rastergröße ergab sich zwangsläufig aus den vorgegebenen Zeiträumen der Erfassung der Daten. Eine Kartierung auf der Basis von geographischen Längen- und Breitenminuten mit einer Grundfläche von ca. 2,2 km^2, wie sie teilweise vom Verfasser im Saarland durchgeführt wurde, erwies sich schon für die relativ kleine Fläche des Saarlandes mit rund 2100 km^2 als nicht durchführbar. Als noch weniger praktikabel erwies sich die Kartierung auf der Basis von 1 km × 1 km Einheiten im UTM-Gitter. Um im vorgegebenen Zeitraum eine hinreichende Genauigkeit der Darstellung der Verbreitung zu erreichen, schien uns der Quadrant (= 1/4 der Fläche der TK 25) die geeignete Rastergröße zu sein (vgl. Abb. 3–5). So lassen sich die Funddaten jederzeit ohne Informationsverlust in eine überregionale Karte der Bundesrepublik im Meßtischblattraster übertragen.

Die Kartierungsgitter sind in den einzelnen Ländern sehr unterschiedlich. Anders als in der Bundesrepublik wird in einigen Ländern auf der Basis eines 10 km × 10 km-Gitters kartiert, und zwar auch unabhängig vom UTM-Gitter (vgl. SEAWARD & HITCH 1982). Für eine europaweite Darstellung ist ein 50 km × 50 km-Raster, entsprechend der Darstellung bei der Verbreitung Höherer Pflanzen (Flora Europaea-Projekt), vorgesehen (vgl. WIRTH, dieser Band). Auch in ein solches, im Vergleich zur Darstellung auf MTB-Quadranten-Basis sehr viel gröberem Raster, lassen sich die Verbreitungskarten ohne allzu großen Informationsverlust überführen. Die von der Kartierung betroffenen Felder (10 km × 10 km) sind in Abb. 2 dargestellt. Die Grundfelder im 50 km × 50 km-Raster sind dicker umrandet.

Angestrebt wird ein mittlerer, gleichmäßiger Bearbeitungsstand (SAUER 1974), der die Verbreitungsmuster am deutlichsten hervortreten läßt (Abb. 3). Parallel zu dieser „Rasterkartierung" werden extrem großmaßstäbliche Erhebungen durchgeführt, unter anderem die Erfassung der Flechtenvegetation auf transparenten Folien (HURKA & WINKLER 1973; WIRTH & BRINCKMANN 1977, WIRTH 1987). Im Saarland liegen solche Flächen in den Naturwaldzellen (AFÖ 1987) und in Rheinland-Pfalz in den Dauerbeobachtungsflächen der Forstlichen Versuchsanstalt (vgl. JOHN & EHRGOTT im Druck). Auch bei der Erstellung immissionsökologischer Wirkungskataster werden in Rheinland-Pfalz und im Saarland epiphytische Flechten berücksichtigt.

Rund 880 Taxa lichenisierter Pilze (Flechten) und lichenicoler Pilze (Flechtenparasiten) konnten bisher im Untersuchungsgebiet registriert werden. Bei der Darstellung in Verbreitungskarten wird in 3 Zeiträume differenziert nach Funden vor 1900, zwischen 1900 und 1960 und nach 1960 (vgl. SEAWARD & HITCH 1982; WIRTH & FUCHS 1980). Dadurch wird bei vielen Arten ein deutlicher Rückgang erkennbar (Abb. 4). Bei anderen Vertretern wiederum stammen sämtliche Funddaten aus jüngster Zeit (Abb. 5). Einer ganzen Reihe gefährdeter Arten steht eine relativ geringe Anzahl von Arten gegenüber, die in Ausbreitung begriffen sind. Die Flechtenflora und -vegetation unterliegt einem starken dynamischen Druck (vgl. WIRTH 1978), dem zum Teil sehr rasche Veränderungen folgen. Diese aufzuzeigen, soll die Flechtenkartierung einen Beitrag leisten. Die enorme Geschwindigkeit, mit der die Flechten dezimiert werden, erfordert im Grunde eine ständige Aktualisierung der Daten. Doch verläuft die Veränderung schneller, als sie dokumentiert werden kann, sei es aus Mangel an Zeit, Personal oder finanziellen Mitteln. Dieser Umstand mag

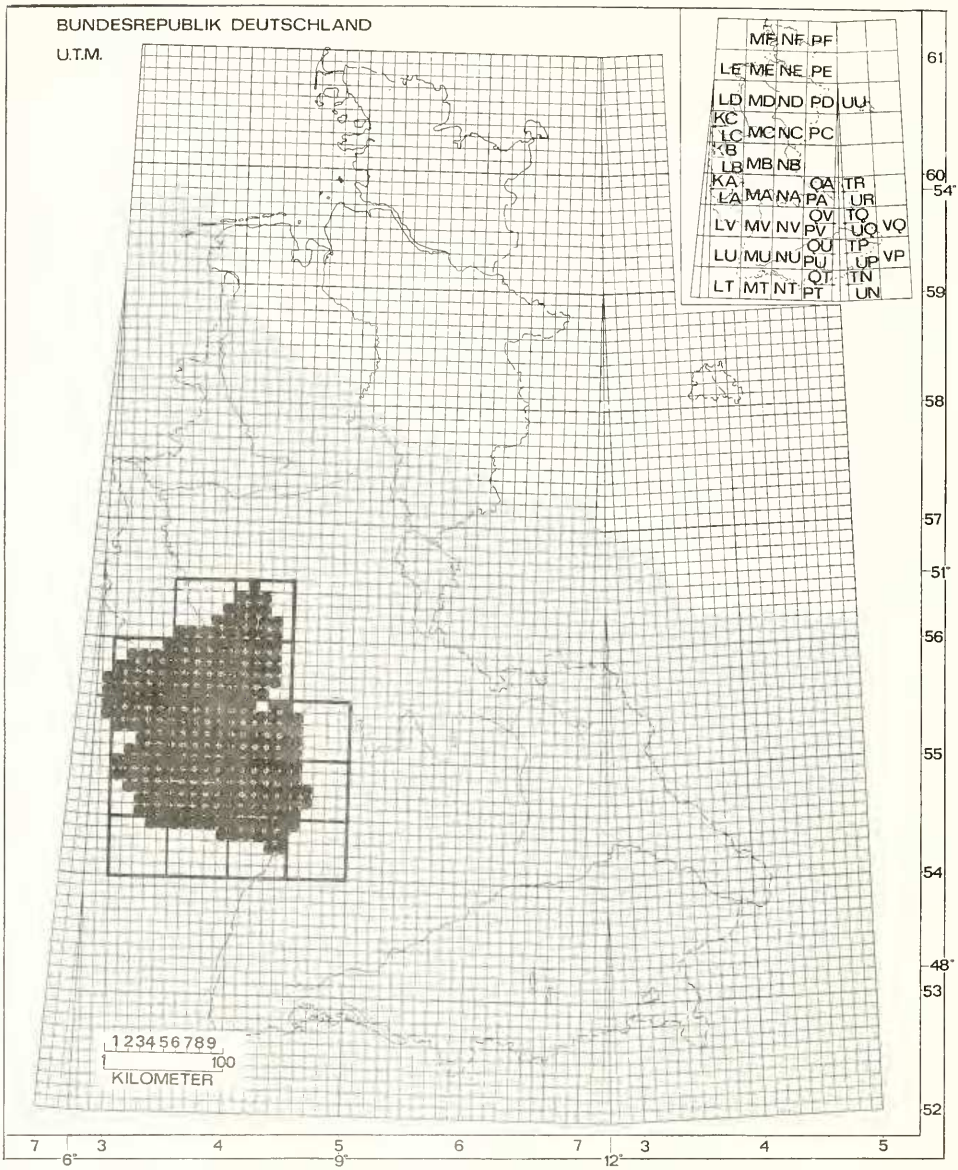
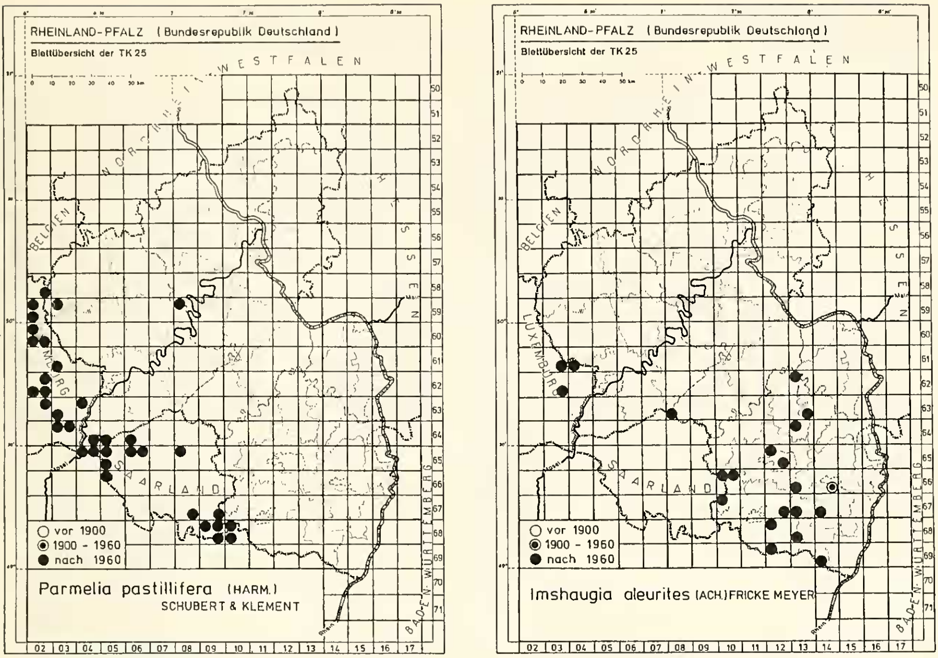


Abb. 2. Kartierungsgebiet im UTM-Gitter im 10 km × 10 km-Raster *(Kreise)* mit der Lage im 50 km × 50 km-Raster *(fette Linien)*.



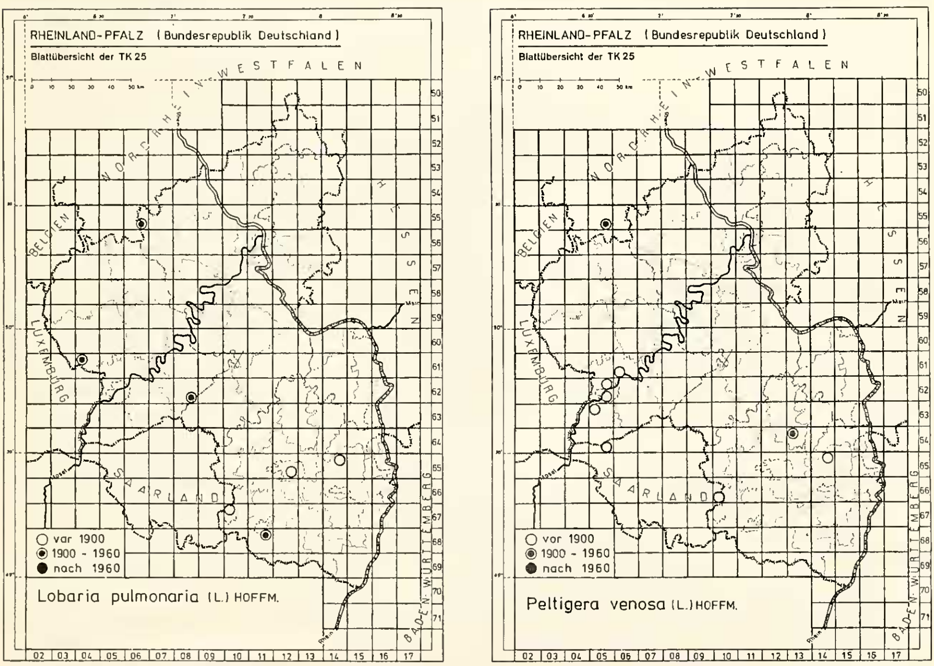


Abb. 3. (oben) Beispiele für Verbreitungsmuster mit deutlichen regionalen Schwerpunkten.
Abb. 4. (unten) Beispiele für Verbreitungskarten ausgestorbener Flechten in Rheinland-Pfalz.

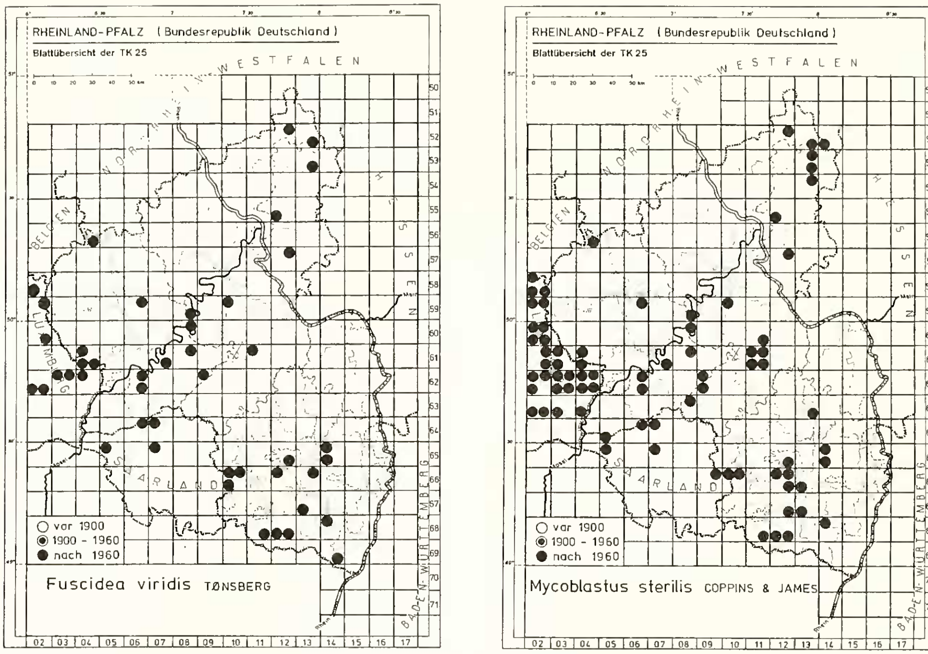


Abb. 5. Beispiele für den Kenntnisstand über das Vorkommen sich ausbreitender Flechten.

die Publikation eines Atlasses der Flechten von Rheinland-Pfalz (incl. Saarland) zu einem so frühen Zeitpunkt nach nur fünf Jahren der Kartierung rechtfertigen. Der Atlas will dementsprechend keinen Abschluß der Kartierung darstellen, da er in keiner Weise den Ansprüchen einer Vollständigkeit gerecht werden kann. Es wird vielmehr der gegenwärtige Bearbeitungsstand dokumentiert; nicht zuletzt durch die aufgezeigten Lücken kann der Bearbeitungsstand gezielt verbessert werden. Gleichzeitig mag der Entwurf einer Roten Liste der Flechten von Rheinland-Pfalz, die etwa 400 Arten umfassen wird, zu einer umweltbewußteren Entscheidung bei der Beurteilung von Flächen beitragen (vgl. JOHN 1988), auf denen die Flechte wie kaum ein anderer Organismus die besonderen ökologischen Verhältnisse widerspiegelt.

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Der Flechtenatlas von Baden-Württemberg – ein Beitrag auch zum Umweltschutz?

Von Volkmar Wirth, Stuttgart

Mit 8 Abbildungen

1. Einführung

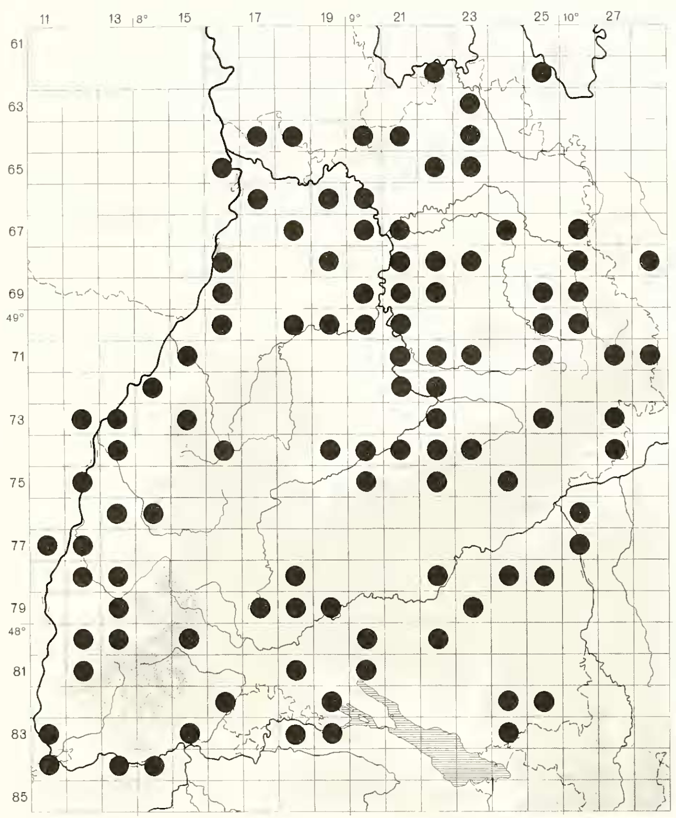
Lange Zeit beruhte die Kenntnis der Verbreitung der Flechten in Baden-Württemberg wie im übrigen Mitteleuropa auf spärlichen, vollkommen unrepräsentativen Fundortsangaben, die mehr die Wohnorte und bevorzugten Sammelgebiete der wenigen Flechtenkundler widerspiegelten als Vorstellungen über das Areal oder die Häufigkeit der Arten vermitteln konnten. Um die äußerst dürftige Kenntnis der Verbreitung zu verbessern, wurde die floristische Durchforschung des Landes intensiviert und 1966 eine planmäßige Rasterkartierung der Flechten begonnen. Diese zunächst nur für den Schwarzwald und seine Umgebung konzipierte Kartierung wurde später auf ganz Baden-Württemberg (Wirth 1978) ausgedehnt. Ein entsprechendes Unternehmen wurde auch für die ganze Bundesrepublik vorgeschlagen (Philippi & Wirth 1973, Wirth & Ritschel 1977). Als Kartierungsbasis dient das bei der Kartierung der Höheren Pflanzen Mitteleuropas eingeführte Meßtischblatt-Raster.

Als Ergebnis der Kartierung in Baden-Württemberg wurde ein Verbreitungsatlas vorgelegt (Wirth 1987). In ihm ist die Verbreitung von annähernd 1000 in Baden-Württemberg vorkommenden Flechtenarten in Punktrasterkarten dargestellt. Ein Computerprogramm ermöglicht die Bearbeitung und Präsentation der Daten, z. B. die Erstellung von Artenlisten und von Verbreitungskarten.

2. Informationsgehalt und Auswertungsmöglichkeiten

1. Der Atlas dokumentiert den gegenwärtigen floristischen Kenntnisstand. Durch intensive, gleichmäßige Durchforschung des Landes stieg die Zahl der aus dem Land nachgewiesenen Flechtenarten um rund 10% auf derzeit ca. 1160. Dazu kommen ca. 70 flechtenbewohnende Pilze, eine Gruppe, deren Erforschung traditionsgemäß zu wesentlichen Teilen von Flechtenkundlern übernommen wird.

2. Der Atlas dokumentiert die Verbreitung der einzelnen Arten. Ein Vergleich mit dem Kenntnisstand vor Beginn der planmäßigen Kartierung (Bertsch 1965) enthüllt eine außerordentliche Zunahme von Fundnachweisen für die einzelnen Arten. Nicht wenige Flechten, die vor Beginn des Kartierungsunternehmens nur in Einzelvorkommen bekannt waren und als selten angesehen wurden, entpuppten sich als verbreitete und recht häufige (Abb. 1), andere als sehr differenziert verbreitete Arten, so daß heute anstelle der chorologisch nicht interpretationsfähigen Einzelnachweise aussagekräftige Arealbilder vorliegen. Wir sind inzwischen nur unwesentlich schlechter über die Verbreitung der Flechten als über die der Höheren Pflanzen in Baden-Württemberg orientiert (Abb. 2–5).



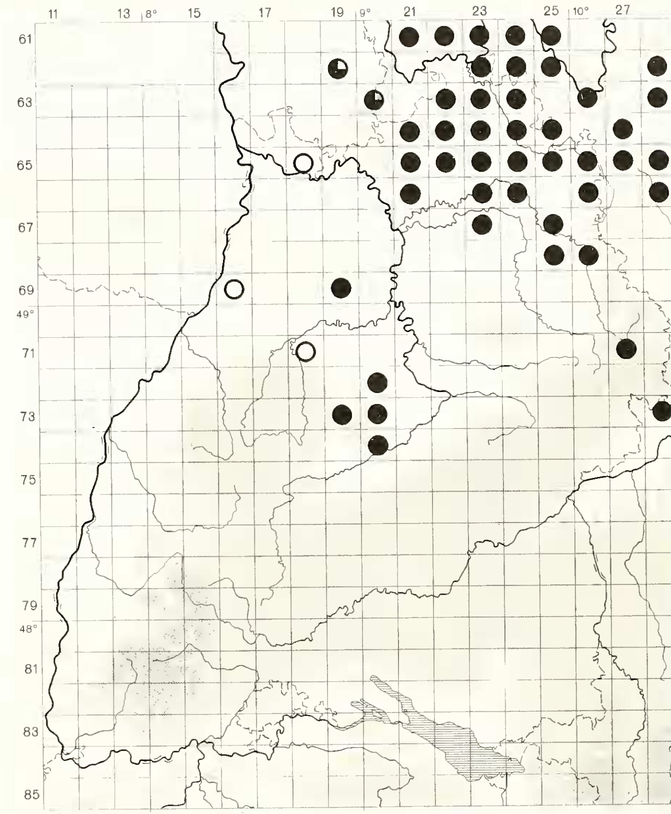
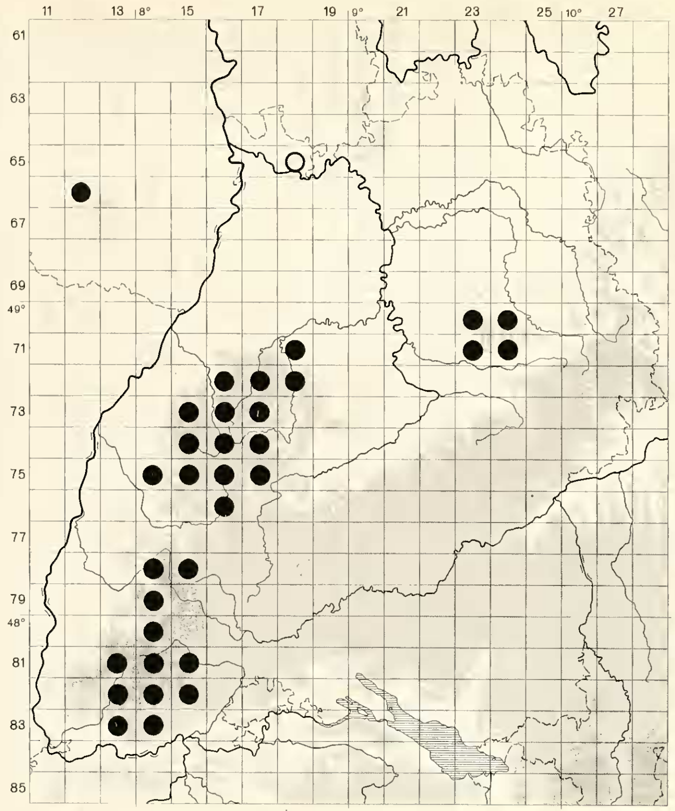


Abb. 1. (links) Heutiger Kenntnisstand der Verbreitung von *Sarcopyrenia gibba.* Vor der Kartierung war die Art nur von zwei Lokalitäten in Baden-Württemberg bekannt.

Abb. 2. (rechts) Verbreitung von *Calicium adspersum* in Baden-Württemberg, einer auf dem Stamm alter Laubbäume wachsenden Kelchflechte.



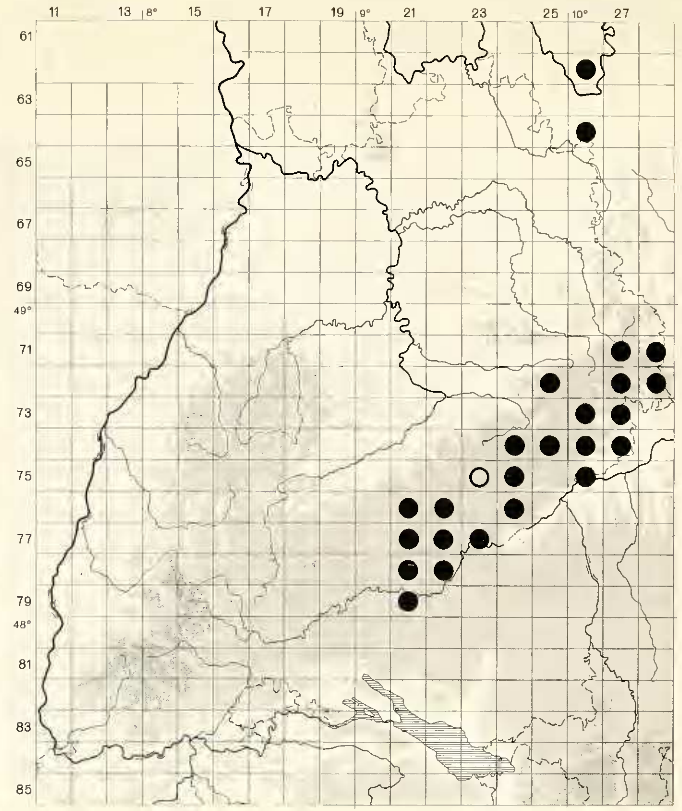


Abb. 3. (links) Verbreitung von *Lecanactis abietina* in Baden-Württemberg, einer vor allem in alten Tannen- und Fichtenwäldern an kühlen Orten lebenden Krustenflechte.

Abb. 4. (rechts) Verbreitung von *Placocarpus schaereri* in Baden-Württemberg, einer kalksteinbewohnenden Krustenflechte.

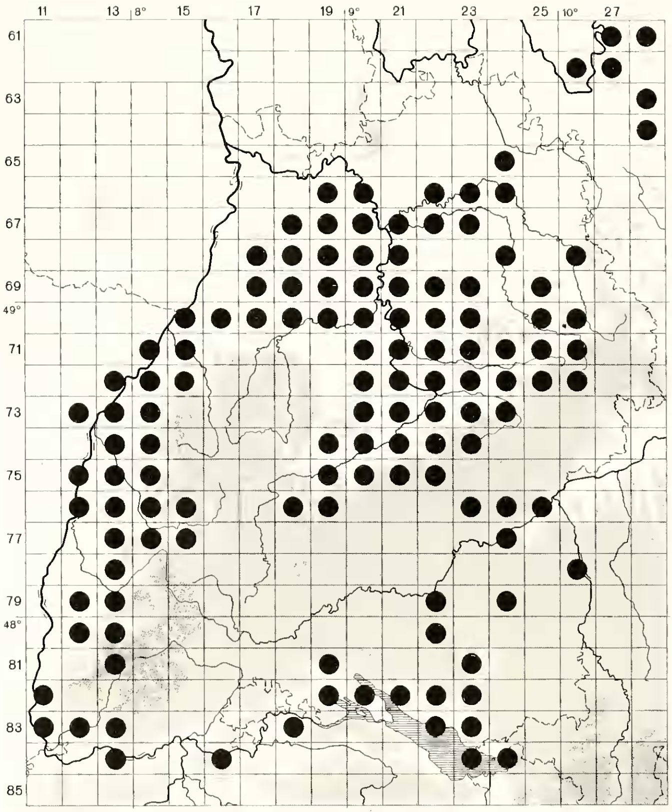


Abb. 5. Verbreitung von *Parmelia flaventior* in Baden-Württemberg, einer auf freistehenden Bäumen wachsenden Laubflechte.

3. Die Darstellung der Kartierungsergebnisse in Form von Rasterkarten erlaubt eine vielfältige Auswertung der Karten mit Hilfe von EDV. Wir können Areale miteinander vergleichen und Arten mit ähnlichen Verbreitungseigenheiten jeweils bestimmten Arealtypen zuordnen. Um der Klärung der Frage näherzukommen, wieweit diese Arealtypen klimatisch oder edaphisch bestimmt sind, können Arealtypen mit entsprechend „gerastert" dargestellten Faktorendaten (z. B. Klimakarten, geol. Karten) verglichen werden.

Abb. 6 stellt das Verbreitungsraster von *Parmelia pastillifera* der gerasterten Faktorenkarte „Niederschläge über 1000 mm" gegenüber. Es ergibt sich eine auffallende Übereinstimmung. Der Schluß liegt nahe anzunehmen, daß für die Verbreitung dieser Art hohe Niederschläge maßgeblich eine Rolle spielen. In vielen anderen Fällen wird man (multifaktorielle) Korrelationen aber nur mit Hilfe aufwendiger EDV-unterstützter Verfahren ermitteln können (vgl. PIETSCHMANN in diesem Band). Beide Auswertungsmöglichkeiten, die Ermittlung von Arealtypen und die Deutung der Areale, werden zur Zeit realisiert. Die Ergebnisse werden zur Spezifizierung der ökologischen Aussagekraft der Flechten beitragen.

4. Der Atlas liefert Informationen über die Veränderungen der Verbreitung der Arten.

Gesteinsbewohnende Flechten konnten ihr Areal dank anthropogener Substrate (Mauern usw.) erheblich über die geologisch vorgegebenen Grenzen ausdehnen. Diese anthropogene Begünstigung und ihr Ausmaß geht durch Kennzeichnung der Vorkommen auf künstlichen Substraten aus den Verbreitungskarten hervor.
Der Förderung mancher, meist gesteinsbewohnender Flechten steht ein starker Rückgang besonders baum- und bodenbewohnender Arten durch anthropogene Einflüsse gegenüber. Wir verfügen über zahlreiche Herbar- und Literaturbelege von Fundorten, an denen die betreffende Art heute nicht mehr existiert. Um den Rückgang optisch zu verdeutlichen, sind ältere Vorkommen, die nicht mehr bestätigt werden konnten, mit besonderen Signaturen hervorgehoben, und zwar zeitlich differenziert. Unterschieden werden (letzte) Nachweise vor 1900 *(Kreise)*, zwischen 1900 und 1950 *(Halbpunkte)*, zwischen 1950 und 1975 *(Dreiviertelpunkte)* und ab 1975 *(volle Punkte)*.

Eines der Beispiele für einen auffallenden Rückgang ist *Sticta sylvatica* (Abb. 7). Zahlreiche Arten sind bereits verschwunden (vgl. z. B. WIRTH 1976). In Baden-Württemberg sind mindestens 80 Flechtenarten trotz gezielter Nachsuche nicht mehr aufgefunden worden und müssen als ausgestorben gelten. Dies sind rund 7% der Flora Baden-Württembergs.

5. Es ist inzwischen weithin bekannt, daß die Luftbelastung durch Schadstoffe für den Rückgang von Flechten eine bedeutende Rolle spielt. Viele Flechtenarten reagieren mehr oder weniger empfindlich auf Schadstoffe und Schadstoffkomplexe, wie SO_2, NO_3^-, Staub, Schwermetalle. Verbreitungslücken weit verbreiteter Arten, für die sich keine plausiblen klimatischen oder edaphischen Ursachen finden lassen, sind zumindest dann mit großer Wahrscheinlichkeit auf Luftbelastungen zurückzuführen, wenn aus diesen Gebieten alte Fundangaben vorliegen. Es ist möglich, mit Hilfe der Verbreitung bzw. Verbreitungslücken unterschiedlich empfindlicher Flechten Gebiete unterschiedlicher Belastung zu differenzieren (Bioindikation). Derartige Flechtenkartierungen als Beitrag zu einem „immissionsökologischen Wirkungskataster" sind lokal – im Bereich von Städten und Ballungsräumen – inzwischen vielfach durchgeführt worden. Die Daten des Flechtenatlasses von Baden-Württemberg erlauben erstmals in Mitteleuropa den Entwurf eines solchen „Wirkungskatasters" für eine großflächige Region. Verbreitungskarten von Epiphyten unterschiedlicher Resistenz wurden ausgewertet und zu einer landesumfassenden Belastungskarte integriert, in der 6 Belastungsstufen differenziert sind (Abb. 8).

Diese Karte informiert nicht über bestimmte Konzentrationen einzelner Luftschadstoffe. Sie kann also nicht die Messung einzelner Schadstoffvariablen ersetzen. Diese oft in die Bioindikation gesetzte Erwartung setzt monofaktorielle Ursache-Wirkung-Beziehungen voraus, die in vielen Fällen sicher nicht einmal annäherungsweise zutreffen. Die Karte ist für Umweltschutzbemühungen deshalb nicht weniger wertvoll als ein Immissionskataster. Sie spiegelt das Ausmaß der biologisch wirksamen Immissions-Belastung auf besonders empfindlich reagierende Organismen wider. Die zugrundeliegenden komplexen Immissionsbedingungen können derzeit noch nicht befriedigend beschrieben werden. Schwefeldioxid spielt nach unserer Kenntnis eine wesentliche Rolle; wir können aber wegen der vielfältigen möglichen additiven und synergistischen Effekte keine sehr weitgehende Übereinstimmung zwischen dem Flechten-Wirkungskataster und Immissionskarten *einzelner* Variablen erwarten. Freilich sind diese Aussagen in erster Linie relevant für Flechten und auch für die sich ähnlich verhaltenden Moose, die eine bedeutende Funktion in

vielen Ökosystemen haben. Zweifelsohne ist aber die Indikation komplexer Belastungen aufschlußreich auch in Bezug auf die den Menschen interessierende lufthygienische Situation. Flechten sind heute, wo die etwas einseitig auf SO_2 ausgerichtete Interpretation der Bioindikation überholt ist, mehr denn je als Frühwarnsysteme zu gebrauchen.

3. Rückgang von Flechten und Konsequenzen für Natur- und Umweltschutz

Es ist beunruhigend, wenn Organismen aussterben. Dies heißt nichts anderes, als daß diesen Organismen die Lebensgrundlage entzogen wurde, unsere Umwelt also eine bestimmte Lebensqualität, Standortqualität verloren hat. Dies bedeutet den Verlust biologischer Funktionen und biochemischer und genetischer Information. Ein Wiedereinwandern von Flechtenarten aus weit entfernten Populationen ist sicherlich in vielen Fällen äußerst unwahrscheinlich.

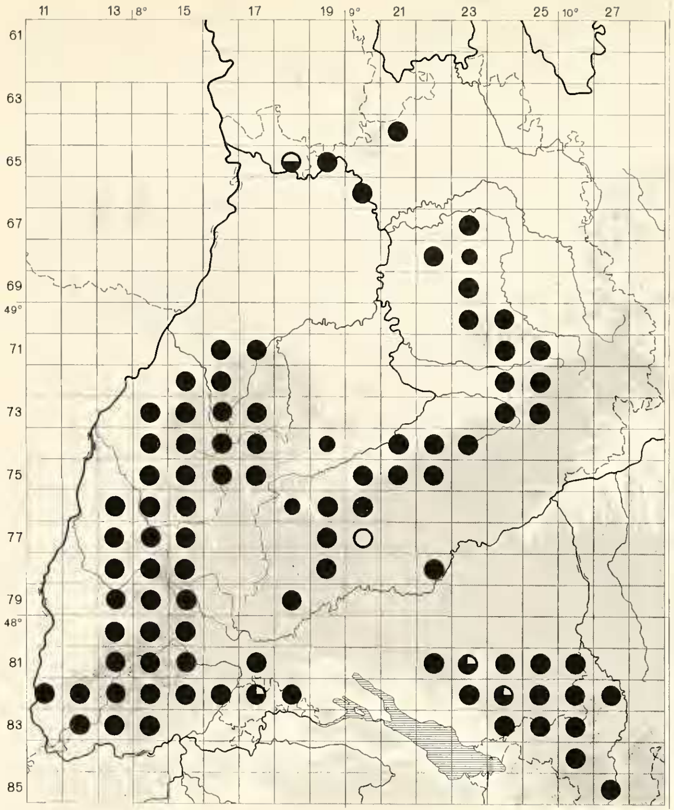
Wenn die oben in Punkt 2, 3 und 4 genannten Ergebnisse der Kartierung als Grundlagen-Information genutzt werden, können vom Aussterben bedrohte Arten ermittelt und durch gezielte Anstrengungen erhalten werden. Arten, die einen drastischen Rückgang zeigen wie etwa *Lobaria scrobiculata, Sticta sylvatica, Collema nigrescens, Pannaria pityrea* und viele andere, sind hochgradig gefährdet. In Baden-Württemberg konnten sich diese Arten noch in einzelnen Vorkommen halten, in vielen anderen Teilen Deutschlands sind jedoch alle Vorkommen erloschen. Dies zeigt die beträchtliche Bedeutung Baden-Württembergs als Refugium bedrohter Flechten, eine Folge des gebietsweise ausgeprägten Reliefs mit sog. „shelter-Lagen" und noch geringer Belastung durch Luftschadstoffe.

Im Prinzip sind auch alle Flechten, die nur von wenigen Grundfeldern nachgewiesen sind, stark gefährdet, auch wenn die Rasterkarte keinen Rückgang erkennen läßt. Diese Arten sind potentiell gefährdet. Es genügt der Bau eines Skiliftes (auf diese Weise wurde das letzte noch bekannte Vorkommen der arktisch-alpinen Laubflechte *Solorina crocea* in Deutschland in den bayerischen Alpen vernichtet, POELT mdl.), die Aufforstung eines Magerrasens, die Verbreiterung einer Straße, um den Bestand entscheidend zu schwächen.

Tatsächlich ist die Luftverunreinigung nur einer von drei für den Rückgang von Flechten hauptverantwortlichen Ursachenkomplexen. Über diesen z. Zt. besonders interessierenden Aspekt werden nur allzu leicht manch andere negative Faktoren übersehen, die viel leichter – zumindest in zahlreichen Einzelfällen – gemildert werden könnten als die Schadstoffbelastung. Einen wesentlichen Anteil am Flechtenrückgang haben forstwirtschaftliche Nutzungsmethoden und die Intensivierung der Flächennutzung durch die Landwirtschaft.

Ein Artenschutz im eigentlichen Sinn kann für Flechten nur Erfolg in Verbindung mit Flächen-, mit Biotopschutz haben. Sammelverbote wären weitestgehend sinnlos. Welchen Nutzen kann ein Artenschutz für die seltene Lungenflechte haben, wenn der Baum, auf dem sie wächst, gefällt wird oder durch eine Fichtenplantage in Dauerschatten gerät? Es ist notwendig, die typischen Flechtenstandorte zu erhalten.

Da wir die Fundorte der gefährdeten oder sehr seltenen Arten durch die Kartierungsunterlagen kennen, ist eine Erhaltung der Habitate durch naturschützerische Maßnahmen im Prinzip ohne weiteres möglich, z. B. durch Sicherung als Naturdenkmal, Naturschutzgebiet, Bannwald oder Vereinbarungen mit Grundstückseigentümern. Allerdings kann Arten- und Biotopschutz nur sinnvoll durchgeführt



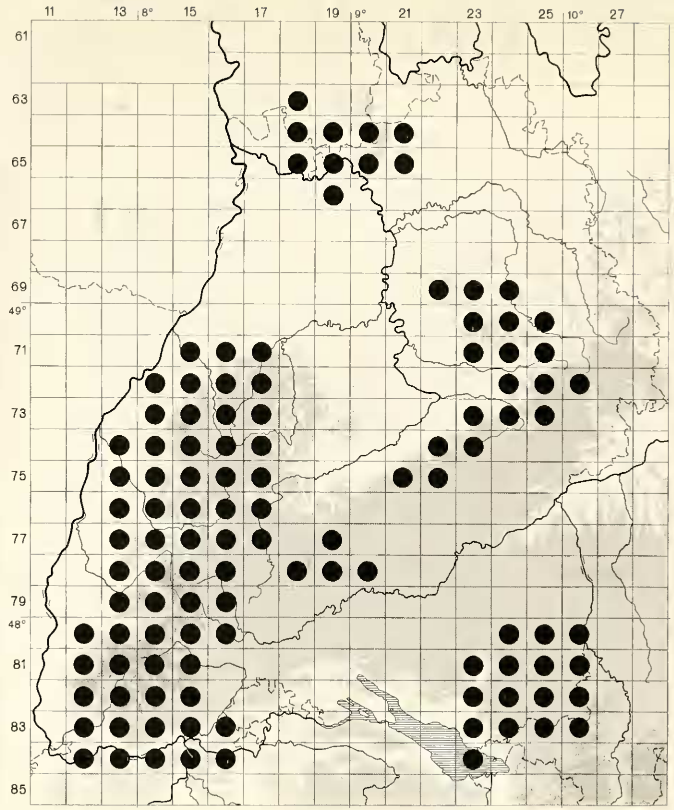
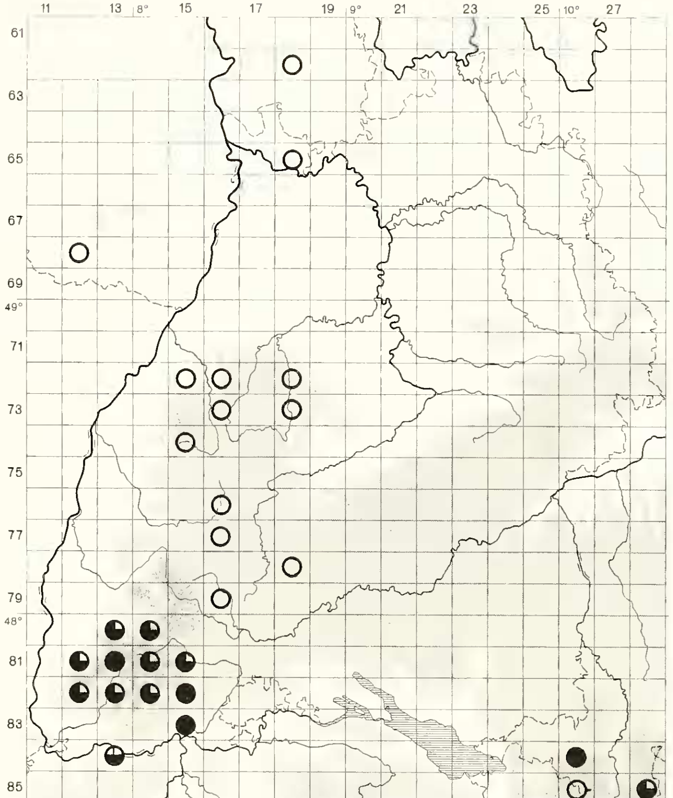


Abb. 6. Gegenüberstellung der Punktraster-Verbreitungskarte der epiphytischen Laubflechte *Parmelia pastillifera* (links) und der entsprechend gerasterten Verbreitung von mittl. Jahresniederschlägen über 1000 mm (rechts).



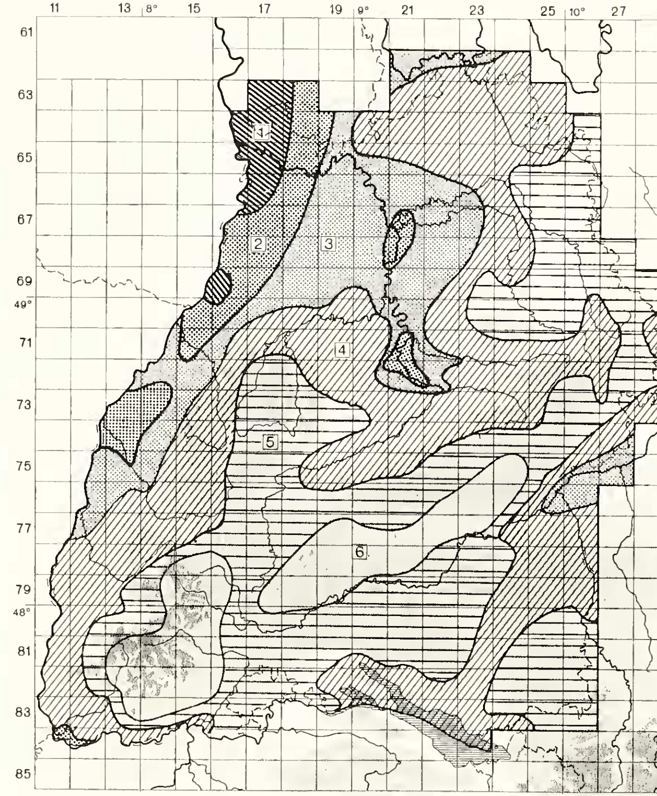


Abb. 7. (links) Rückgang der ozeanischen Laubflechte *Sticta fuliginosa*. Seit 1975 wurden nur noch die mit einem Punkt dargestellten Vorkommen bestätigt.

Abb. 8. (rechts) Immissionsökologisches Wirkungskataster von Baden-Württemberg, basierend auf Flechten-Daten. Unterschieden sind Zonen verschieden starker Verarmung der Flora (**1:** Verarmung sehr stark, **6:** rel. gering), die unterschiedlich starker Belastung durch Immissionen entsprechen (aus WIRTH 1987).

werden, wenn wir die Ursachen des Flechtenrückgangs berücksichtigen. Die räumliche Sicherung eines Flechtenfundortes muß begleitet sein von der Sorge um die Erhaltung der Standortbedingungen. Wir müssen wissen, welche Standorttypen generell besonders bedroht sind. Gerade auf sie müssen sich die Anstrengungen des Naturschutzes konzentrieren. Im Falle der Flechten sind z. B. felsblockdurchsetzte Magerrasen (Gefahr der „Entsteinung“), Trockenmauern, Steinrasseln, Streuobstwiesen, Wald-Altbestände bedeutend. Oft – wenn wirtschaftliche Interessen im Spiel sind – kann sich der Naturschutz nicht diesen, von besonders hohen Verlusten betroffenen Habitaten widmen, sondern weicht auf Flächen von geringem ökonomischen Wert aus.

4. Werden die Informationen über bedrohte Flechten und ihre Standorte vom Natur- und Umweltschutz genutzt?

Die Folgen forstwirtschaftlichen und – in den letzten Jahrzehnten in ständig steigendem Maß – des modernen landwirtschaftlichen Managements, dabei in erster Linie die verheerenden ökologischen Wirkungen der Flurbereinigungen, werden zwar von biologischer Seite immer wieder betont, aber auf Behördenseite nicht recht zur Kenntnis genommen, schon gar nicht beherzigt. Ohne Zweifel werden heute Flechten weithin beachtet, wenn es um ihre bioindikative Aussage bei Luftbelastungen geht. In scharfem Gegensatz dazu steht das noch sehr geringe Interesse an der Existenz und Existenzerhaltung der Flechten überhaupt und an ihrer Aussage über Ökologie, Seltenheit und Schutzwürdigkeit bestimmter Standorte. Die Gelegenheit, die Kenntnisse über Vorkommen von Flechten und anderen Niederen Pflanzen umzusetzen, wird zur Zeit ganz sicher ausgelassen. Dies gilt für Forst- und besonders für die Landwirtschaft.

Die Verantwortlichen für die nur wenig gebremsten Bereinigungen in Weinbaugebieten, ob auf der Ebene der Flurbereinigungsbehörden oder der Ministerien, ziehen immer noch viel zu wenig Konsequenzen aus den wiederholt von Botanikern, Zoologen und Ökologen vorgebrachten Argumenten gegen die praktizierte Form der „Bereinigungen“. Die von staatlicher Seite unterstützten Erhebungen oder Kartierungen nützen sehr wenig, wenn die Ergebnisse nicht umgesetzt werden. Als Argument für die Bereinigungen werden immer wieder Probleme wirtschaftlicher Art genannt, die bei genauerer Betrachtung lediglich aufgeschoben werden, auf Kosten von Lebensgemeinschaften, die unwiederbringlich vernichtet werden.

Immer wieder kommt es bei Rebflurbereinigungen zu den gleichen Interessenskonflikten, bei denen zwar heute mitunter gewisse Forderungen des Naturschutzes in Alibiflächen erfüllt werden, im Grunde aber stets der (in manchen Fällen nachweislich nicht realisierbaren) Ökonomie anstelle der Ökologie der Vorzug gegeben wird. Die Zahl der Kilometer der vernichteten Weinbergmauern ist unbekannt; sie ist Legion. Die Bedeutung dieser Weinbergmauern beschränkt sich nicht auf Reptilien; bei der Diskussion um die Erhaltung dieser Lebensräume gewinnt man vielfach den Eindruck, daß die ökologische und biologische Argumentation mit gut sichtbaren Lebewesen endet. Trockenmauern aus Keupersandsteinen (Schilfsandstein, Lettenkeupersandstein) bieten durch ihre spezifische subneutrale Oberflächenreaktion für eine Gruppe seltener Moose und Flechten eine der wenigen möglichen Standorte. Der Restbestand dieser Keupersandsteinmauern wird infolge der Flurbereinigungen schätzungsweise inzwischen unter 1% liegen. Das bedeutet eine über 99%ige Vernichtung der Populationen dieser spezifischen subneutrophytischen

Arten. Auch von den Naturschutzbehörden wird noch vielfach die Vernichtung kleinwüchsiger Pflanzen und Tiere wenig beachtet und der Verlust ökologischer Vielfalt nicht richtig eingeschätzt. Selbst bei den ganz wenigen verbliebenen Weinbergen mit kulturhistorisch gewachsener Gliederung durch Weg und Mauer (z. B. im Stromberggebiet) akzeptieren die Naturschutzbehörden noch Kompromisse in der bisherigen, ökologisch unbefriedigenden Form.

Es ergibt sich die merkwürdige Situation, daß Behörden den „Wert" der alten Weinbaulandschaft kennen und Gelder für deren Untersuchung zur Verfügung stellen, andererseits die Erkenntnisse nicht umgesetzt werden. Wie grotesk gehandelt wird, illustriert die Nachricht (Stuttgarter Zeitung vom 21. 6. 90, p. 20), daß der Umweltpreis der Stadt Stuttgart an eine Projektgruppe verliehen wurde, die 6 m Trockenmauer an einem Weinberg im Stuttgarter Stadtgebiet wieder hergerichtet hatte, andererseits im Bereich desselben Weinberges trotz heftiger Proteste durch die Flurbereinigung 6 km Weinbergmauern mit ihrer ganz spezifischen Moos- und Flechtenflora vernichtet werden.

Verheerend ist auch die Abnahme bestimmter Magerrasen-Typen. Während für den Schutz von Halbtrocken- und Trockenrasen auf kalkreichen Böden wegen ihres Reichtums an Orchideen und anderen attraktiven Seltenheiten immer wieder gesorgt wurde, sind Silikatmagerrasen, insbesondere Flügelginsterheiden und Borstgrasrasen, vom Naturschutz vernachlässigt worden. Diese Rasen sind blumenreich; Flügelginster, Arnika, Heidekraut, Katzenpfötchen, Silberdistel, Rundblättrige Glockenblume und viele andere Arten sind Angehörige dieser Gesellschaften, die sich im Schwarzwald hauptsächlich im gemeindeeigenen Allmendgebiet ausbreiten, welches als Viehweide über Jahrhunderte hinweg extensiv genutzt wurde. Sie wurden nicht gedüngt und nicht gemäht. Man bezeichnet dieses Gebiet auch treffend mit „Wildes Feld". Diese auch landschaftlich sehr reizvollen, oft von flechtenbedeckten Felsblöcken oder Steinhaufen durchsetzten Weidfelder sind in den letzten 20–30 Jahren in ungeheurem Maße zurückgegangen. Zum kleinen Teil wurden sie aufgeforstet, zum großen Teil in Intensivweiden und Fettwiesen umgewandelt, durch Ausbringung von Gülle aus den subventionierten Schwemmentmistungsanlagen der Bauernhöfe, mit verheerenden floristischen und faunistischen Konsequenzen. Wir verfügen durch eine pflanzensoziologische Kartierung des Meßtischblattes Freiburg-Süd von OBERDORFER und LANG aus dem Jahre 1954 über eine hervorragende Information, wie die Vegetation zu dieser Zeit aussah und somit über die Möglichkeit, die zwischenzeitlichen Veränderungen quantitativ zu beurteilen (OBERDORFER 1957). Im Kartierungsgebiet sind die Borstgrasrasen in rund 30 Jahren auf 0,08% der damaligen Fläche reduziert worden (HOBOHM & SCHWABE 1985). Mit der Vernichtung großer Flächen von Flügelginsterheiden und Borstgrasrasen ist nicht nur Raubbau an blumen-, pilz-, flechten- und ungemein insektenreichen Pflanzengemeinschaften getrieben worden, sondern auch ein reizvolles und kulturhistorisch wertvolles Element der Schwarzwaldlandschaft nahezu ausgelöscht worden.

Hier ist nur beispielhaft angedeutet, wie viel in jüngster Zeit zerstört worden ist. Ich fürchte, daß in vielen Fällen das Positive, das im Zusammenhang mit der Intensivierung der Flächennutzung in die Waagschale geworfen werden kann, leicht wiegt im Vergleich dazu, was an Kultur- und Naturlandschaft, faunistischem und floristischem Reichtum verlorenging, leicht wiegt gegenüber der Trauer vieler Menschen über die verlorene Landschaft.

Die Zeit ist überraschend schnell gekommen, in der nach den Naturschützern vielfach beklagten monotonen Bachkorrektionen die kostenintensive „Renaturierung" folgte – ein im Grunde vernichtendes Urteil für die Kurzsichtigkeit der verantwortlichen Behörden. In manchen Gebieten ist auch bereits der Weinbau in die Defensive gegangen. Wenige Jahre nach verzweifeltem und vergeblichem Bemühen, Trockenrasenflächen im Anschluß an Weinberghänge zu erhalten und nicht in Rebflächen umzuwandeln, wird in Unterfranken bei enttäuschendem wirtschaftlichem Verlauf beim Absatz heimischer Weine die Anbaufläche ortsweise zurückgenommen!

Es bedarf, meine ich, keiner prophetischen Gabe vorauszusagen, daß die Tätigkeit der Flurbereinigungsämter, auch in der heute etwas gemilderten Form, in nicht allzu langer Zeit mit wesentlich kritischeren Augen gesehen werden wird. Die Berücksichtigung von Flechten bei Planungen der Behörden und Ämter mag manchem übertrieben erscheinen; in der Tat werden sie selbst noch von manchen Naturschutzbehörden als nicht relevant für ihre Tätigkeit angesehen. Da sie ja aber bestimmte Standortqualitäten und Lebensgemeinschaften „vertreten", die einen erheblichen Sektor unserer Umwelt ausmachen, kann ihre Berücksichtigung eine zu einseitig auf wenige Tier- und Pflanzengruppen ausgerichtete Erhaltung von Biotopen und Lebensgemeinschaften vermeiden helfen und zur Erhaltung einer mannigfaltigen Umwelt beitragen.

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Part IV: List of Participants

With 1 figure

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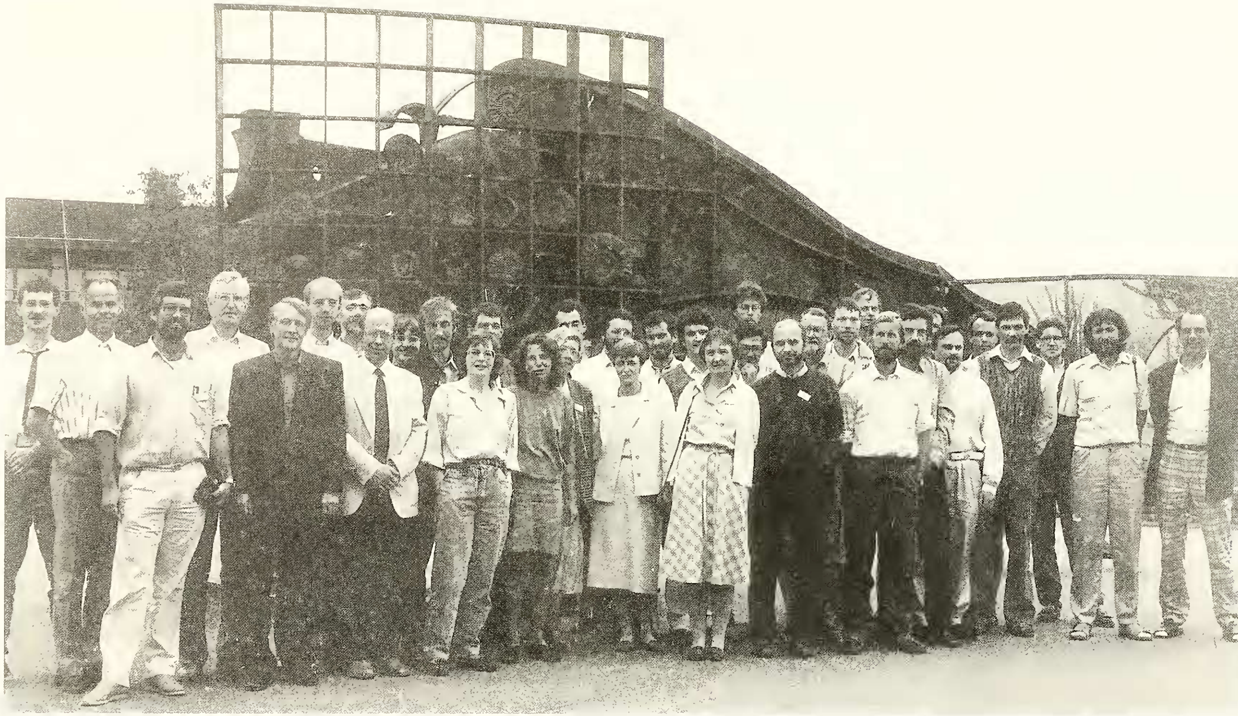

Fig. 1. Participants in front of the State Museum of Natural History Stuttgart. – From left: P. Jacobsen, H. Kristinsson, E. Ruoss, R. Moberg, V. Wirth, P. Diederich, F. Batič, D. L. Hawksworth, accomp. person, H. Schöller, Elisabeth Schlechter, M. Lerond, Angelika Niebel-Lohmann, Chantal van Haluwyn, M. Pietschmann, A. Gomez-Bolea, Regine Stordeur, W. Obermayer, C. Scheidegger, Edit Farkas, J. Egea, M. Tretiach (back), E. Sérusiaux, I. Pišút, E. Woelm, H. T. van Dobben, U. Søchting, P. Scholz, T. Feuerer (partially hidden), R. May, G. Ludwig-Holdmann, V. John, H. Oberhollenzer, J. Liška, R. Türk.

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